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EVERYTHING PNEUMATIC.

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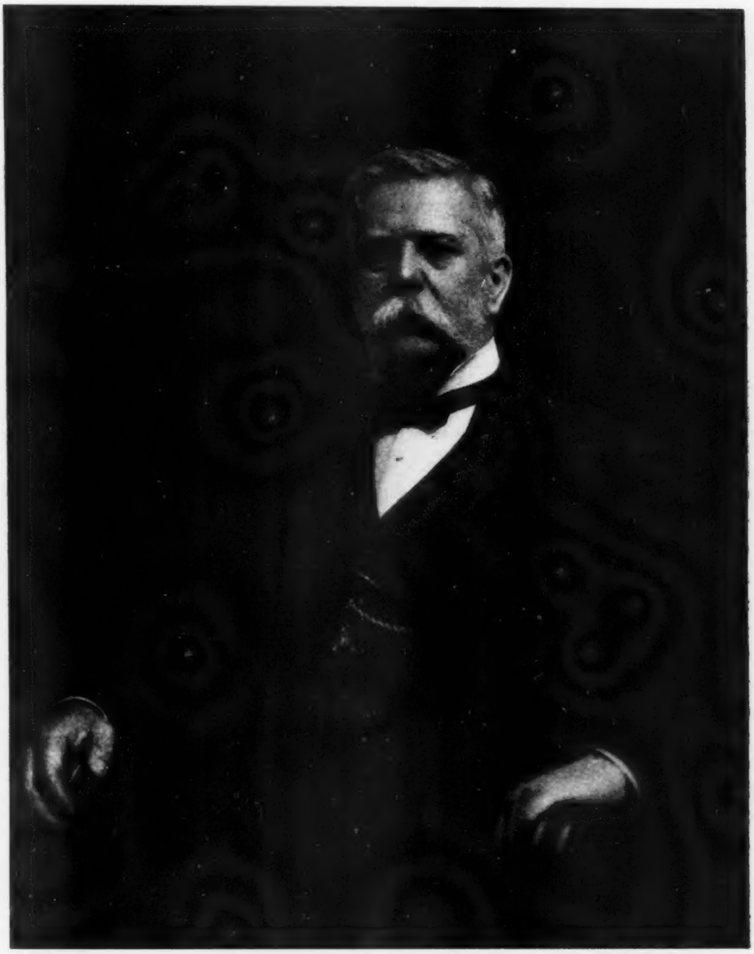

Geo. Westinghouse

GEORGE WESTINGHOUSE

One of the world's greatest and most successful inventors, an organizer of wide reaching industries, a maker of history not to be ignored in any broad view of human progress, has passed away. He will always be best known to all the world as the inventor of the air brake, and in that capacity he appeals especially to the readers of Compressed Air Magazine, but the reach of his activities embraced much more than that.

Mr. Westinghouse died in New York City March 12, of chronic heart disease, which began its manifestations fifteen months before. Through all his active and strenuous life he had never been critically ill before, and the sudden breaking of his health came as a great shock to his family and associates. He had not left his room for three months, and he was unconscious for three days before the end came.

We may not know what plans were left uncompleted, or what a prolonged life might have produced for the augmentation of mechanical means and methods and in the extension of engineering practice, but his record was already full of completed accomplishment.

But a brief and incomplete sketch of the career of Mr. Westinghouse can be given here. He was born at Central Bridge, Schoharie County, N. Y., Oct. 6, 1846. When he was ten years old the family moved to Schenectady, N. Y., where his father was for many years head of the Westinghouse Agricultural Works, and the son was thus given a mechanical impetus from the beginning. At the age of fifteen he had made a tolerably successful rotary engine. In June 1863, before he was seventeen, but he was six feet tall and weighed 180 pounds, he enlisted in the Twelfth New York Infantry. In November he joined the Sixteenth New York Cavalry, serving a year and being discharged a full corporal. A month later he was appointed a third assistant engineer in the navy, and he served in different ships to be honorably discharged at the close of the war.

He at once entered Union College taking the classical course, and his college record is unique. He did not graduate, but he was not dismissed for any fault. The President of the college frankly said to him: "You are wasting your time here. You are a faithful student, but our classical course is not likely to be of any service to you. You know as much of mathematics, if not more than we can teach you, and you have a genius for invention. The college work is holding you back from your absorbing interest. Continue as you are going and you will become a great engineer."

He took the wise president's advice and took out his first patent, which was for a re-railing frog. Returning from a visit to Albany he had been delayed by the derailing of a freight-train. He watched the futile efforts of the trainmen and at once devised the frog. With two other men who put up $5000 he started his first factory for the manufacture of the frogs, retaining the patents in his own name. The partners seized the business and without Westinghouse it soon failed. He soon after became a salesman for a steel casting company who took up the frog again and made it a success.

The same year what must be considered his life-work began. In one of his trips between Schenectady and Troy he came upon a bad train wreck, a head-on collision on a straight track. The danger had been seen by the engineers in good time but the hand brakes could not be set soon enough. In those days the engineer could only brake his engine, and a couple of toots of the whistle was the only signal to the brakemen on the cars, and they could only respond slowly, applying one brake at a time even when they realized the urgency of the danger.

This started the alert inventor upon a problem which we realize now was not a simple one which could be successfully solved by a single stroke of ingenuity. Various arrangements were thought of and some were tried without success: automatic brakes attached to the couplers, steam actuated brakes, but the right idea finally came to Mr. Westinghouse upon his reading of the success of the air actuated rock drill in the Mont Cenis tunnel. The first convincing test of the brake, not simply as a brake or as a car brake, but as a *train* brake was in 1868, and the first patent was dated April 13, 1869, the complete record of Mr. Westinghouse's personal patents amounting to over 300. The first road to adopt the brake was the Pan-handle. The Pennsylvania took it up and all the others followed with a rush.

Of the details of the air brake inventions the triple valve must be considered the most original and ingenious and the most important. This reduced the time for full application of the brakes on a ten car train from twenty-five seconds to eight seconds, or it reduced by nearly a quarter of a mile the distance in which a train at forty miles an hour could be stopped, but this was only the beginning.

Perhaps not less important was the development of the application of the brake on freight trains. In a string of fifty cars the full force of the brakes would not be applied to the rear cars in less than eighteen seconds, and this sometimes meant consequences almost as disastrous as a collision. Trains buckled and telescoped, broke couplings and drawbars. Mr. Westinghouse studied out the problem, and in the summer of 1887 he made modifications in the triple valve which allowed full application through long trains in two seconds. In October and November of that year a demonstration train made a triumphal tour of the country, and railroad men were amazed when they saw a loaded freight train, a third of a mile long and running at forty miles an hour, stopped smoothly in 581 feet.

The air brake pump, as it is familiarly designated, was another ingenious detail of the air brake equipment which had the rare merit of being perfectly adapted to the service for which it was designed. It has been kept up to date by successive improvements, and no other inventor has been able to supersede it. It reliably and automatically maintains the required pressure in the system without any looking after when out on the road, and if it is not as economical of steam as it should be, the steam used by it is often that which otherwise would be escaping more noisily by the safety valve.

The air brake pump has incidentally been one of the greatest and most efficient missionaries for the promotion of the general employment of compressed air for other purposes. Spare pumps are practically always available in railroad shops, and this has led railroad men into the habit of thinking compressed air, and of devising new and various ways of getting it to help them.

Mr. Westinghouse was well equipped with the push and the business faculty which too many inventors, unfortunately have lacked. Retaining the control of his invention he undertook the entire manufacture of it and organized the Westinghouse Air Brake Company, establishing at Pittsburgh the business which became the nucleus of the many industries associated with his name. After the success of the air brake it came quite naturally in the way of the inventor to apply compressed air to the operating of switches and signals and from this grew the Union Switch and Signal Company.

This line of employment brought Mr. Westinghouse in close touch with electricity and he turned his helping brain to the quickening of the phenomenal developments then in progress. He was quick to see and to take advantage of some of the yet undeveloped possibilities. He devoted his energies to the utilization of the alternating current for lighting and for power transmission, and in this he had to meet and overcome fanatical opposition which went the length of trying to procure prohibition legislation.

In 1885 he acquired the patents of Gaulard & Gibbs and he personally devised apparatus and methods for the distribution and utilization of electric currents in a large way, besides which he gathered about him a group of men who were to become experts in the novel field thus opening to the world. He organized the electrical company which bears his name and undertook the development and manufacture of the induction motor, which made practical the utilization of the alternating current for power purposes.

Then still another line of opportunity found Mr. Westinghouse ready for it. Following the discovery of natural gas in the Pittsburgh region, he devised a system for controlling the flow and for conveying the gas over long distances through pipe lines. He took up the study of the gas engine, and for ten years conducted a series of exhaustive experiments in this line and then put into commercial use a gas engine of large power for electric generating and for rolling mill work.

Still again, Mr. Westinghouse introduced the Parsons steam-turbine into this country, adding developments and improvements of his own or carried out under his supervision. He also developed a special steam turbine for ship propulsion, co-operating with the late Rear-Admiral Geo. W. Melville and John H. Macalpine in their study of the problems as-

sociated with the driving of propellers at low speed by turbines of high speed.

It is quite unpracticable if not impossible for us to enumerate the inventions which Mr. Westinghouse personally made or those which his staff have brought out under his supervision. The latest seems to have been the pneumatic spring for automobiles, and of this it may be assumed that all the possibilities connected with its employment have not yet developed. As a result of his work and enterprise there grew up thirty corporations of which he was president, employing 50,000 men and $120,000,000 capital, with works at Wilmerding, East Pittsburgh, Swissvale and Trafford City, Pennsylvania; at Hamilton, Canada; London and Manchester, England; Havre, France; Vardo, Italy, and at Vienna and St. Petersburg.

Mr. Westinghouse made many visits to Europe. Not only had his fame spread over all the world but he won the friendship of the foremost men of his time and the high esteem of the engineering profession. He was decorated by the French Republic and by the sovereigns of Italy. He followed his friend Lord Kelvin as a recipient of the John Fritz medal. The Königliche Technische Hochschule of Berlin bestowed upon him the degree of Doctor of Engineering and his own Union College, from which he did not graduate, gave him the degree of Ph, D. Besides his Honorary membership in the American Society of Mechanical Engineers and his Presidency of the Society, Mr. Westinghouse was one of the two honorary members of the American Association for the Advancement of science and an honorary member also of the National Electric Light Association.

Mr. Westinghouse must be regarded not only as a successful but also as a fortunate inventor and man of affairs. He had from the beginning the fullest freedom to avail himself of his opportunities as they arose, and apparently had no family or other discouragements or hindrances. He was highly fortunate in his physical and mental endowment. He was fortunate in having secured without apparent special effort in that direction the pecuniary reward which so many fail to attain. He was fortunate in having secured the highest respect and esteem of them who knew him, and the world was fortunate in the life and work of a great man.

LOSSES TO THE NATION FROM MINE ACCIDENTS AND MINERAL WASTE*

There is no exact measure of the losses from mine accidents and mineral waste, but we may use an approximate measure. If the increasing rate of coal-mine fatalities during 1905, 1906, and 1907, the three years prior to the beginning of this work, had continued throughout the four subsequent years, since Congress authorized these mine-exposion investigations, the number of fatalities would have been at least 4,000 greater than they have actually been. At approximately the average compensation paid in fatal mine accidents of the past few years, this would represent a national loss of $12,000,000 in the four years. If it is remembered that for every fatal accident there are at least three to five serious non-fatal accidents, and twelve lesser accidents which incapacitate for one or more days, it will be seen that the actual national loss expressed in money value would have been much larger.

In mineral waste, the national loss is estimated to be not less than $1,000,000 a day. This loss for the most part is not such as may be considered as representing a deferred use of resources, but represents a total permanent loss of national wealth.

The mineral losses are considered as national losses for the reason that the mineral products of the country, becoming articles of interstate commerce, are used by the people of all the States quite regardless of their source. For the same reason, the cost of investigations looking to the prevention of these losses should not fall upon any one State; and if conducted by each of the States, the result would be extensive and unnecessary duplication of effort and expenditure. We cannot expect the individual operator to bear the cost of such investigations for the reason that waste prevention with him is a question of temporary profits, and his temporary profits, in many cases at least, are greater by virtue of his following wasteful methods. With both the community and the Nation the situation is often quite different, and they must safeguard their own permanent welfare.

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*From the third annual report of the National Bureau of Mines, Joseph A. Holmes, Director.

FIG. I. ELECTRIC AIR DRILLS AT PLEASANTVILLE, N. Y.

CONTRACTORS' PLANTS ON THE NEW YORK STATE BARGE CANAL

BY CHAS. A. HIRSCHBERG.

The State of New York has long been noted for its gigantic engineering projects, some of them, the Barge Canal, Catskill Aqueduct and Hudson River Tunnels, ranking among the first of the world's great engineering achievements, which in years to come will be recognized as monuments to the boundless effort and resourcefulness of the men who conceived them and those who had the courage and temerity to undertake their building. But aside from the credit due the engineer and builder, there is a coterie of designing engineers and manufacturers to whom a great deal of credit is due for the genius displayed in the design and supervision of the building of the various machinery that made the prosecution of these engineering undertakings a commercial and expeditious success.

This machinery has become a familiar sight to the big majority of people and, with the exception of certain special equipment which is mentioned later, is familiar to the man who has knowledge of general mining and quarrying methods and machinery. Briefly they may be divided into the following general classes:

Air Compressors.
Mounted Rock Drills.
Submarine Drills.
Deep-hole Drills.
Hand Hammer Drills.
Drill Sharpeners.
Channelers.

The air compressors may be subdivided into several minor groups according to the driving means employed: steam, belted power and direct-connected electric.

Among others may be mentioned the following air compressor installations on the Barge Canal: Arthur McMullen, Delta, N. Y., Class "A" steam driven type; Acme Engineering & Construction Co., Herkimer, N. Y., Class "AA-2" steam driven machines; Kinser Construction Co., Fort Edward, "Imperial" Type "X" steam driven; H. P. Burgard, Buffalo, N. Y., two-type "XB-2" belt driven compressors; Oswego Construction Co., Fulton, N. Y., Type "XB-2" belt driven; Larkin & Sangster, Lockport, N. Y., Class "PB-2" belt driven compressors; P. McGovern Co., Mechanicsville, N. Y., Class "NF-1" steam driven. While these represent but a few of the compressors in use, they will serve the purpose of this article, as it is the intention to touch on but one or two installations at any great length.

The Class "A" air compressor is of the single-stage air, straight line type, embodying rugged simplicity and high "all-around" economy. The steam valve gear is of the plain "D" slide type.

The Class "AA-2" air compressor has steam valves of the balanced adjustable cut-off type. The air end is of the most advanced type of two-stage construction, with a very large overhead intercooler and completely water-jacketed cylinders. This compressor is the recognized standard in straight line construction. It combines compound economy with the simplicity, compactness and "unit" quality of the plain, single, straight line type.

The "Imperial" Type "X" air compressor is of the duplex type. The air end is built either simple or compound. Inlet valves are of the well-known "Imperial" Corliss type and discharge of valves of the "Imperial Direct-Lift" pattern which insure the admission and discharge of a full cylinder of air at every stroke. The steam valves are of the Meyer cut-off type on large sizes and plain slide on small.

Class "NF-1" air compressor is ideal for the small contracting plant. It embodies every up-to-date improvement; dust-proof, enclosed construction, unusual simplicity, automatic splash lubrication, high speed and large capacity with minimum dimensions.

At Herkimer the Acme Engineering & Construction Co. have in use the plant formerly located on their contract at Vischer's Ferry. The installation at Vischer's Ferry was perhaps of especial interest because of its central location in relation to the contract as a whole.

All the engines and pumps at Vischer's Ferry were driven by compressed air, with the exception of one derrick. The plant consisted of two Ingersoll-Rand 24-inch steam, 26¼ and 16¼ air by 24-inch stroke two stage compressors, driven by steam furnished by five 100 H. P. boilers of the portable, return tubular type.

After being compressed to 100 pounds the air passed to a 5-foot by 18-foot vertical receiver, located just outside the building, from which point it was distributed to different parts of the contract. One air main leads to the machine shop where it operates a 20 H. P. engine driving the shop tools, also a 300-pound hammer and several forges.

A second line furnished air for a 9 by 10 Lidgerwood hoist on a traveling derrick with an independent swinging engine, a 5-inch plunger pump and a 12-inch direct-connected centrifugal pump, drills used in the excavation, etc.

A third line supplied the work in the main dam, in a similar manner also two revolving derricks located on an island.

A fourth line ran directly to the island and supplied air to several 10-ton cable engines, hoists, etc.

At dam 2, Crescent, was installed an Ingersoll-Rand belt-driven compressor with air cylinders 25¼ and 26¼ by 16-inch stroke, having a capacity of 1,205 cubic feet of free air

FIG. 2. DRILL WAGONS AT STILLWATER, N. Y.

per minute. This air was used for running hoists and drills at the quarry, several hoising engines at the canal and for machinery used for work in the river.

A great many Rock Drills have been used on the Barge Canal work of various types and sizes, such as the Sergeant F-24, E-24, the Butterfly C110 and the 5-F Temple-Ingersoll.

The Sergeant type of drill has long been a favorite with contractors owing to its rugged design, superior valve movement and rapid drilling qualities. It is recognized as the standard tripod drill. The distinguishing feature, its valve movement, is a combination of the independent air-thrown valve with the Tappet valve action, retaining the enhancing advantages of both valve types. This superior valve mechanism has been applied on a structure of the best design and materials, resulting in a drill, which for hard service is the most powerful, effective and reliable machine on the market.

The Butterfly "C110" type is a drill of 3¾ inch cylinder diameter, embodying the Butterfly valve, which is non-freezing and rapid moving, giving the machine a large drilling capacity. The cylinder and front head are made from "Irco" metal, the toughest, longest wearing mental ever employed in any rock drill. It is practically indestructible, and breakages are unknown. The Butterfly Drill is much lighter than the ordinary rock drill and yet will do more work.

Temple-Ingersoll Electric-Air Drills were used by F. A. Maselli, Rochester, N. Y., and by the contractors who succeeded Gilmour, Horton & Allen at Oswego. They were originally purchased by Gilmour, Horton & Allen when this portion of the canal was started.

This drill in general consists of two units, the drill proper and the pulsator. The drill itself resembles in appearance the ordinary compressed air drill, and is mounted on a tripod in the usual manner. The air for driving this drill is furnished by the pulsator which is electric motor driven, the air being supplied to alternate ends of the drill by means of a closed circuit between it and the pulsator. In this manner the air is used over and over again and advantage taken of its expansive properties. The air is never exhausted and what leakage occurs is provided for by a compensating valve on the pulsator, which automatically keeps the volume of air in the system constant.

Of the hand hammer drill class, two types, the Jackhamer BCR-430 and Butterfly BA-23 seem to have been the favorites, there being a great many in use all over the canal for breaking up boulders, trimming, etc. The latter is of the hand rota-

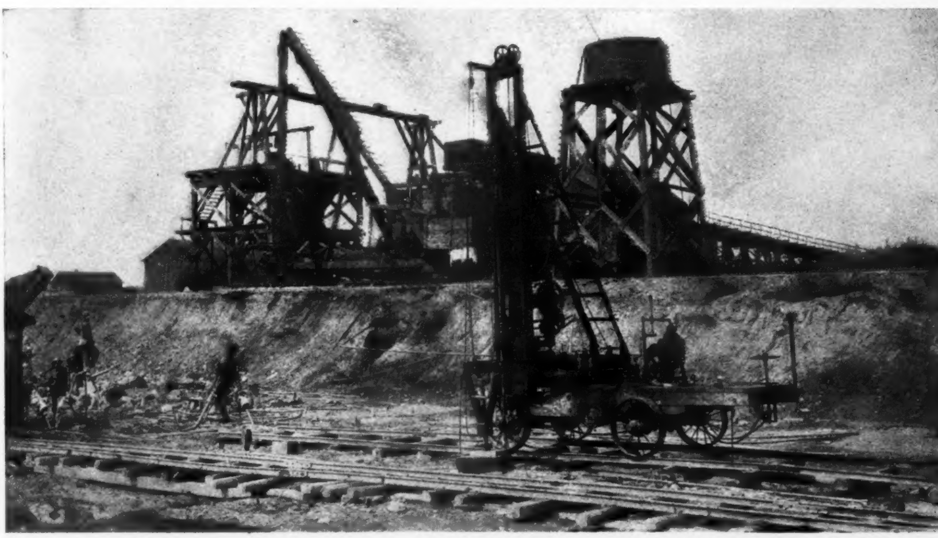

FIG. 3. TURNTABLE DRILL WAGON AHEAD OF STEAM SHOVEL.

ted type, weighing 43 pounds, capable of drilling a hole 5 or 6 feet deep.

The former (Jackhamer) is a self-rotating drill of remarkable drilling capacity that may be operated by steam or air. It is a great favorite owing to the self-rotating feature, as it does not fatigue the operator. In addition the Jackhamer is provided with a hole-cleaning device, which is simple and easy to manipulate.

features of design which guarantee high economy, great power, reliability and large cutting capacity. It is designed for heavy work and deep cuts. Steam being used, it was equipped with an upright boiler.

A comparatively new, yet highly efficient addition to the contractor's equipment is the Leyner Drill Steel Sharpener. Among others is one in use by the Acme Engineering Co.

FIG. 4. DRILL IN ROCK CUT, WHITEHALL, N. Y.

This hole-cleaning device, in conjunction with a steel holder that permits moving the steel up and down in the drill hole, enables the operator to keep the hole free from cuttings, steels are not stuck and as a result the percentage of working time is high. Both drills are provided with automatic lubricators.

Ingersoll-Rand H-8 steam track channelers are in use by the McDermott Co. (now being carried on by the Oswego Construction Co.) at Fulton, N. Y., and Lane Bros., Rochester, N. Y.

This channeler is a direct-acting, single-gang machine, marked by a massive strength and

at Herkimer, N. Y., and H. P. Burgard, Buffalo, N. Y., where it sharpens the steel used in conjunction with Sergeant, Butterfly, Jackhamer and other drills.

Owing to its great compactness, it is an ideal equipment for the contractor, as it takes up but little room, is fool-proof and simple in operation, one lever controlling the entire machine. Compressed air is the motive power. This sharpener uses an entirely enclosing die of conical shape in which the bit is made and gauged, insuring a perfectly formed gauged bit. The importance of properly sharpened steel in drilling operations has long been rec-

ognized as a factor in speedy and economical rock drilling, and the Leyner Sharpener offers a solution of the problem.

Submarine Drills are in use on a number of contracts along the Canal; by the Stewart-Kerbaugh-Shanley Co. at Three Rivers, New York; the Acme Engineering Co. at Herkimer; Huston Barnard at Little Falls; James Stewart Co. at Brewerton, N. Y., and Great Lakes Construction Co., North Tonawanda.

been used with great success in meeting deep-hole drilling conditions on certain sections of the New York State Barge Canal by the Acme Engineering Co. at Herkimer; Huston Barnard at Little Falls; Shanley & Morrisey at Mechanicsville; Great Lakes Construction Co., Pendleton, N. Y.; Lane Bros. on the Genessee River. The holes put down were 4 inches in diameter and 15 feet deep. As high as 160 to 200 feet of hole per shift per machine was drilled. The machines were of the 15-foot

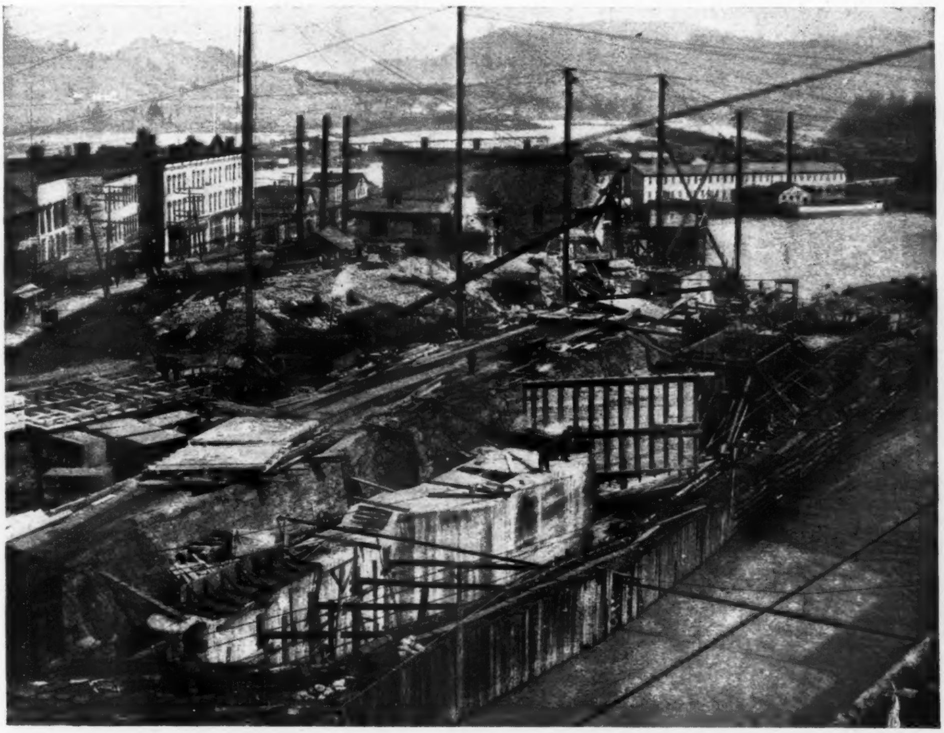

FIG. 5. WHITEHALL, N. Y., A. G. & P. CO.'S CONTRACT, AIR HOISTS.

They are of the H-64 type, with a cylinder 5½ inches in diameter and 8-inch stroke. This style of drill is considered standard by contractors having heavy submarine drilling to do, besides being used on the larger deep hole drill wagons. It is of the well-known New Ingersoll type, and is a machine of great simplicity and durability, the valve action is independent, being operated by air or steam and controlled by the piston, the drill is bolted to a slab back to run in guides and hoisted by means of a cable and donkey engine.

The deep-hole drill Fig. 3, is one that has

feed, turntable type, mounting a drill of 5½-inch cylinder diameter and 8-inch stroke, H-64 Submarine type. The canal construction where this type of drilling rig was employed consisted in the deepening of a portion of the Hudson River Channel to form a waterway for barge traffic 200 feet wide and 12 feet deep in the clear.

The running gear is of the three-point suspension type, comprising heavy steel wheels with flanges for travelling on a 6-foot 3-inch gauge track and provided with power traction, through the medium of a chain drive from a

reversible steam engine, mounted on the wagon. The engine is about 7-H. P. and, while not intended for continuous traction, supplies sufficient power for moving the wagon from hole to hole. A hand wheel and steering gear are also provided at the front end of the wagon.

The drilling engine and its guides, derrick for hoisting steel, etc., are carried on the turntable, which is mounted just past the center of the wagon, at the rear end. This turntable runs on balls. A system of sheaves and ropes suspends the drill from the top of the derrick, from where the ropes lead to a reversible hoising engine which is fastened to the back of the drill guides. Powerful hand brakes on the hoist regulate the feeding of the drill. Heavy jack screws are provided for supporting and steadying the drill frame during drilling operations. The swinging of the turntable is accomplished by means of a geared hand winch and rope. A half circle, 10 feet in diameter, is described when swinging, and the holes can be placed anywhere on this line.

A brief description of the manner of handling and methods of drilling with the turntable rigs follows: The progression of drilling operates by the drill frame being swung at right angles to the line of progress, the jack screw set and a hole drilled; the drill is then raised and swung parallel with the line of progress and another hole drilled; the drill is then again swung at right angles to the opposite side and a third hole drilled. In this manner three holes are put down from each position of the machine, two on a line at right angles, the distance apart depending upon the sweep of the drill frame and one-half this distance in advance of or behind the others, and on a line midway between them. The drill wagon is then moved forward or back the proper distance and three more holes drilled. When the needed length has been covered, the drill is moved and another triple row of holes,

FIG. 6. ROCK CUT FOR LOCK, WHITEHALL, N. Y.

paralleling the first, put down, and so on continuously. In the meantime, after sufficient ground has been drilled, blasting may be inaugurated, without interferring with the drilling.

For successful drilling of deep holes it is necessary to devise some means of ridding the holes of cuttings. The only successful method of accomplishing this is to use a water jet alongside of the drill steel. A pipe about ½ inch in diameter is suspended from the top of the derrick, which can be raised or lowered to suit the position of the drill bit. This will give the best results when handled so that the end of the pipe will not be more than 12 or 18 inches above the bottom of the hole. This pipe is connected by means of rubber hose with either a steam pump mounted on the top of the turntable, the pump suction being connected to any convenient water supply, or to a water pressure line. The amount of water is under the convenient control of the operator. In operation the drill runner stands on the turntable where he has control over the operation of the drill. The helper tends to the water jet and steel, lowering the pipe with the steel. As soon as a hole is finished a wooden plug is dropped in to keep it clear until ready for loading. The steel used was solid, 2 inches in diameter, 15 feet long, with a 4-inch cross-bit.

Outfits such as those mentioned above are being built by this company for a diversity of applications and are fast taking their place as necessary adjuncts to the contractors' equipment. They find their application in the economical excavation of rock in quarries, rail road cuts, canals and work of a similar nature where holes of a great depth are required. Their advantage for this class of work over the ordinary tripod drill are manifold, principally noticeable in the saving of time and labor. As stated they are designed to drill deep holes of large diameter, requiring fewer changes of steel and making heavy power loading possible, so that springing of holes becomes unnecessary. The speed and ease with which these machines are moved about makes possible the accomplishment of more drilling.

With tripod drills a great deal of time is consumed in moving from hole to hole, requiring considerable labor to do so. With these rigs several holes are drilled at one setting. The accurate spacing of holes of large diameter equally distributes the work, making it possible to break more ground with fewer holes.

PNEUMATIC TOOL EFFICIENCIES*

BY H. L. BRACKENBURY.

The pneumatic hammer is a combination of a cylinder, reciprocating piston, a valve controlling the flow of motive fluid to and from the cylinder and a throttle valve in the supply pipe. All the earlier engines were designed to produce rotary motion or to work pumps. The idea of using a free piston was first suggested as a good means of rock drilling. Among the earliest inventors in this field was George Low, an Englishman, who in 1865 patented a rock-drill having a hammering piston. Low is perhaps chiefly interesting as being the first to show a grasping-handle with manually-operated throttle valve within the control of the operator's fingers. Low was followed two years later by Doering, another Englishman, who was the first to patent a pressure-operated valve for this class of machine, in which the piston and valve are mutually inter-dependent, a principle used in all modern pneumatic hammers.

The first serious attempt to produce a practical metal-working pneumatic hammer seems to have been made by Boyer, of St. Louis, who, in 1883, patented a chipping machine with a grasping-handle and a throttle valve controlled by hand. Benjamin Brazelle, of St. Louis, in the early eighties obtained a patent in the United States for a steam pump disclosing a differential-area piston attached to a pump plunger, together with a differential-area valve, each of which served to control the operations of the other. Boyer seems to have drawn inspiration from Brazelle's invention, for in 1896 he brought out a metal-working pneumatic hammer involving Brazelle's design, but modified to suit the conditions of chipping, caulking, and riveting.

It was soon found that there was a large field for pneumatic hammers for closing rivets, and this demand for pneumatic riveters led to the invention of the hammer in which a comparatively short piston was made to travel a distance much in excess of its own length.

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*From a paper read before the Coventry Engineering Society, Coventry, England, January 23, 1914.

Boyer was probably the first to make a long-stroke hammer about 1899 by employing a valve at each end of the cylinder connected together by two rods of small diameter placed in longitudinal passages drilled in the walls of the cylinder. Meissner of St. Louis at about the same time brought out a long-stroke hammer with one valve only.

The problems presented to the manufacturer of pneumatic tools differ considerably from those involved in the production of other machines actuated by a fluid under pressure. The desirable qualities in a pneumatic tool in their order of importance appear to be: Reliability, power, cheapness, lightness, ease of handling, compactness and low air consumption.

ENORMOUS WASTES OF AIR.

Up to the present probably too little importance has been attached to the last of these. It is no uncommon thing to find a large and expensive air-compressor plant eating up power and delivering enormous volumes of air to supply the incessant drain of leaking pipes and hose, and the intermittent demands of most wasteful types of tools. Perhaps it would be no exaggeration to say that quite generally the amount of air lost by leaking hose is almost equal to that used by the pneumatic tools themselves. Suppose there are a number of leaks equivalent to a circular hole of about 1-10 in. in diameter. If the air supply be at 100 lb. per sq. in. pressure, the air leak will be about 15 cu. ft. of free air per min. or about 2 cu. ft. per min. of compressed air. The power required to compress this will be nearly 3 hp. In other words, the leak would waste about 120 cu. ft. of compressed air per hr.

METAL DRILLING MACHINES.

The factors governing the design of pneumatic drilling machines are entirely different from those for fixed machines. In the latter case, the machine is designed to run the drill at the speeds and feeds which will give the quickest penetration without undue wear to the drill. In the case of the pneumatic drill, the power is the governing factor, and therefore the design must be such as to use that power to rotate the drill at the speed at which the greatest penetration is given for the power. This is a slow speed, not a high one. The author found that an ordinary drilling machine requiring, for the same rate of penetration with fast speed and fine feed, double the power required with slow speed and coarse feed. These experiments were made with a drill in careful alignment with the work, and not with a pneumatic drilling machine supported by a springing arm and starting with the drill at anything but right angles to the surface of the work. The result is that the best effects are obtained by running the drill at slow speeds. The limits in this respect would be reached if the pressure required to feed the drill were more than could be conveniently given by the feed gear or the torque exceeded the strength of the drill body or cutting edge.

SPEEDS AND FEEDS.

When the air is allowed to flow into the drilling machine, a high speed of rotation is set up until the feed is applied by the feed screw. The more rapidly the feed screw is rotated the quicker will be the penetration of the drill and the slower will the drill rotate, with the final limitation that if the feed is too rapid, the drill will stall suddenly and there will be no penetration. This appears to be a curious paradox, for, apart from considerations of wire drawing, the indicated horsepower of the pneumatic engine would seem to be dependent on its speed and the pressure of the air. The result arrived at is that the maximum speed of penetration is given by that speed of rotation at which the machine develops its minimum horsepower, but its maximum stable torque.

Considerable experience of running drills under test conditions has proved the importance of applying the feed with judgment. A man used to this work can get much better results out of a drill than can another man, equally intelligent and skilful, who is not so accustomed. It requires the greatest judgment to feed the drill so rapidly that it shall just escape stalling.

The idea of a minimum speed at which the pneumatic drill will run without stalling is of importance, because it should help to fix the gear ratio to be employed between the pneumatic motor and the twist drill. This critical speed is probably dependent not only on the size of the twist drill and the material it is to cut but also upon the laws connecting the torque of the pneumatic motor with its speed of revolution, while this relation in its turn depends upon the pressure of air supply and the length and bore of the flexible hose.

The history of other prime movers would indicate the probability that there will, and should, be an increase in the speed of revolu-

tion of the pneumatic motors. Everything is to be gained by obtaining increased power from the same piston by running it faster, provided the design still ensures reliability and good wearing qualities. If this change occur, it will involve an increase in the gear ratio between the drill and pneumatic motor.

Pneumatic drilling machines may be divided into two classes. The first class comprises those operated by an engine of the piston and crankshaft type, the second those which rely upon some form of rotary engine. The second type is attractive on account of its beautiful simplicity, but, so far, the author has not found one capable of giving as large a torque for a given air consumption as those of the first type. The principal difficulty in producing even a reasonably efficient rotary pneumatic engine is the large leakage, which seems almost inevitable.

In considering the efficiency to be expected from either type, we should remember that the problems to be faced by the manufacturer of an engine as minute as that required for a pneumatic drill are peculiar to the production of any small device operated by a fluid under pressure. Since the periphery of a body is proportional to its linear dimensions, while its area varies as their square, it follows that the leakage which occurs at a periphery assumes greater and greater relative importance as the size of that part decreases, and leakage is the principal bugbear of the designer of pneumatic tools.

TESTING PNEUMATIC DRILLING MACHINES.

The measurement of the brake horsepower of a pneumatic drilling machine offers no particular difficulty if great accuracy be not required. For commercial purposes a prony brake is quite satisfactory. If, however, it be desired to investigate comparatively small changes of brake horsepower, a number of difficulties have to be surmounted.

Two forms of brake have been tried. The first consisted of a hollow copper jacket resting on a sheave, which was driven by the drill. The back center of the drill abutted on a support carried on an old lathe shifting head. The whole arrangement was fitted to a discarded lathe bed. Arrangements were made to keep a stream of cold water flowing continuously through the copper jacket. The latter was lined with lead, so as to bear evenly on the sheave. To one end of this copper jacket there was attached a heavy weight resting on a spring-balance, while a lighter weight attached to the other end was immersed in a vessel of oil, which damped down the oscillations until they did not exceed about ¼ lb. on the spring balance. Of course the lighter weight was corrected for the up-thrust of the oil. This arrangement was only fairly satisfactory. The brake used with it consists of a fine-quality cotton webbing, and the sheave has been made of larger diameter so as to minimize the rise of temperature.

It was found that over the speed range under investigation, 150 to 200 r.p.m., the horsepower developed increases more slowly than the revolutions. This speed range only was considered, because, it corresponded to the actual rate at which the drill would be run in practice.

TESTING PNEUMATIC HAMMERS.

The practical testing of pneumatic drills is difficult, but the testing of pneumatic hammers for power is even more so. The apparatus used in testing pneumatic hammers consists of a massive cast-iron bed provided with T-grooves, so that a heavy block may be bolted to it in any desired position. Against this block is placed the handle of the hammer to be tested. The snap of the hammer abuts against a heavy block, which can swing about a vertical pivot fixed to the bed. This swinging block is controlled by a spring, which can be adjusted by means of a screwed bolt passing through the fixed abutment. To the swinging block is fixed a light-steel arm carrying a stumpy pencil, the point of which rests on a strip of paper which can be reeled by hand off one drum on to another. As the instrument is only required to give the speed of the hammer, and a general idea of the type of oscillation produced, there is no need to employ a uniform drive for winding the paper.

Finally, although the production of a perfect pneumatic hammer appears to be more difficult than the production of a perfect pneumatic drilling machine, the author believes that the designs of hammers have reached a point nearer finality than the designs of drilling machines.

The 650 large ventilating fans in the anthracite mines of Pennsylvania are estimated to deliver 45,126,000 cubic feet of free air per minute.

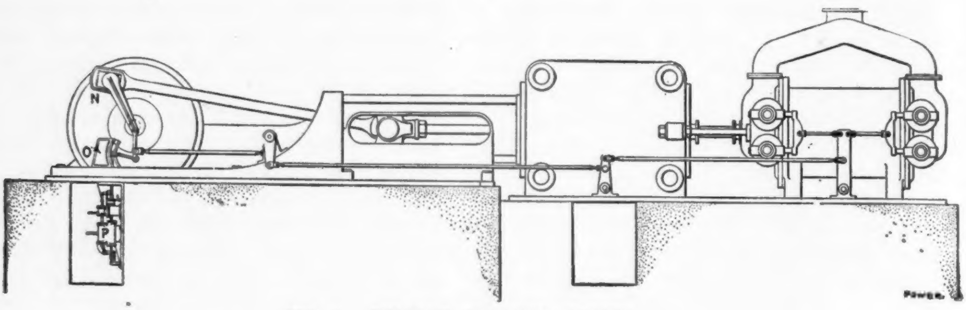

FIG. 1. HOLMAN BLOWING ENGINE.

A NEW BLOWING ENGINE

Prior to the introduction of the gas engine, it was the general blowing-engine practice to limit the piston speed to 600 ft, per min., although cases were known where speeds of 800 ft. were employed. To furnish the requisite amount of air for the blast furnace at such speeds as this required a ponderous and costly engine, and it was found desirable to increase the piston speed to 800 or 1000 ft, per min. to keep down the size of the engine. As a consequence, it was necessary to adopt some new design of blowing tub with much larger valve openings than formerly, so that the cylinder at the increased speed would be properly filled with air. To meet these requirements a new type of blowing engine has been designed by R. C. Holman. Its construction is shown in the accompanying illustrations.

It is claimed by the designer that a blowing engine of the type shown can be built having inlet ports 25 per cent. of the area of the cylinder, and outlet ports 15 per cent. of the area of the cylinder, with a volumetric clearance of not over 1 per cent.

To remove both inlet and outlet valves from the cylinder it is necessary to take off the bonnet and withdraw the valve exactly as any Corliss valve is taken out. This valve contains all of the inaccessible parts of the air-distributing mechanism and will fit in any of the valve ports in the cylinder, provided that the ports are all bored alike. One complete valve in reserve then will provide a full set of repairs for any of the valves.

In the past, the use of flat girdiron and Corliss valves for blowing engines has not been attended with the best results, on account of the difficulty in properly lubricating the inlet valves. There is always enough oil pumped into the cylinder to properly lubricate the outlet valve, as the air leaving the cylinder is laden with oil. In the Holman machine the oil is pumped directly on the surface of the inlet valve at the edge of the port.

Fig. 2 shows the inlet valve-gear side of a horizontal blowing cylinder, and Fig. 3 the out-

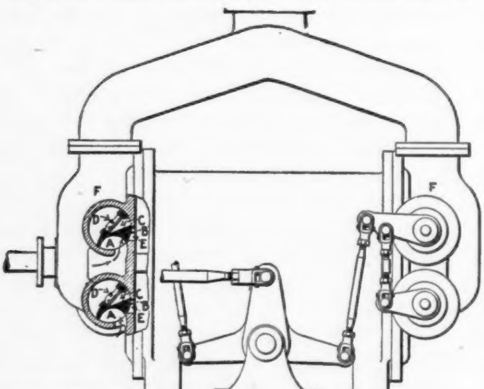

FIG. 2.

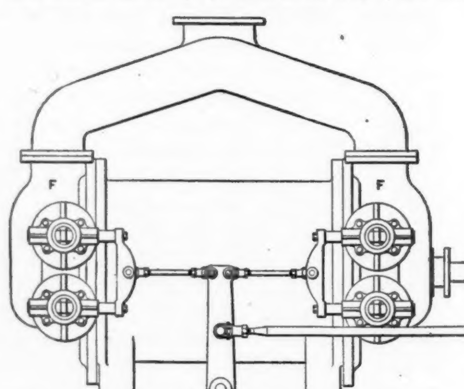

FIG. 3.

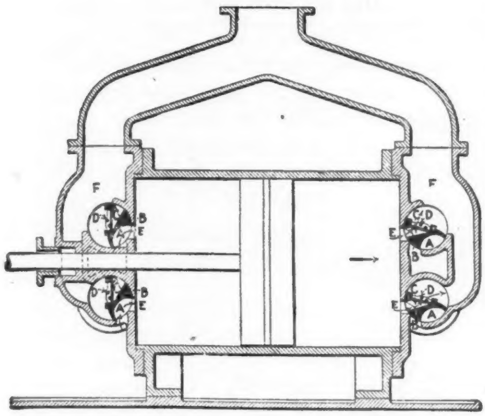

FIG. 4.

let valve-gear side. Fig. 4 is a section on the vertical center line through the cylinder and shows the valves in their proper relative position for the piston as shown. Fig. 5 is a section through the center of the valve and shows the outlet gridiron valve at the back of the inlet Corliss valve.

As will be apparent, the cuts show a steam-driven unit. The power is taken directly from the crankshaft and pin, while with a gas engine the valves are driven by eccentrics mounted on a layshaft, similar to the manner in which the inlet and outlet valves on the gas cylinder are driven.

Referring to Figs. 2, 4 and 5, *A* represents the inlet port through the inlet Corliss valve *B*, and *C* is the outlet port. The ports *E* in the cylinder head are alternately inlet and outlet ports, depending whether the piston is approaching or receding from the cylinder head. Each cylinder head contains two valves exactly alike, which are connected and work in unison. It is because both ports are used as inlet or outlet, as the requirements may be, that it is possible to secure such large openings with so small volumetric clearance.

The circular Corliss valve *B* of the sections shown in Figs. 2, 4 and 5 is given the proper oscillating motion by the valve-gear shown in Figs. 2 and 3, which is driven from the crankshaft in the case of a steam engine and from the layshaft of a gas engine. It is provided with the inlet and outlet passages referred to, and is fitted to a tee-headed valve stem *M* in the ordinary manner.

At one end of the outlet passage *C* through the valve *B* are cast a series of bars making gridiron openings through the valve, as in Fig. 5. The valve *B* is machined at this point to form a seat for the gridiron valve *D*, the openings through which correspond to the gridiron openings in the valve *B*, Rectangular ports *E* are cast in the cylinder head and act as inlet ports to the cylinder when the valves are in the position shown at the left of Fig 4, and as outlet ports from the cylinder when the valves are in the position shown at the right of Fig 4. At the center of the cylinder *F* is a passage connecting the discharge from each valve with the blast pipe. Fig 5 is a horizontal section through *F*, and Fig. 2 is a section at one side of *F*. In Fig. 5, *G* are thrustwashers with a spring to hold the valve *B* from slapping back and forth with the movements of the gridiron valve *D*. In practice, however, these washers are only needed in starting, as the unbalanced pressure of the valve stem *M* is more than the friction of the gridiron valve *D*. A cam bar *H* gives motion to the crosshead *I*, which in turn operates the gridiron valve *D*, the thrustwashers *K* being used to transmit motion and at the same time allow the gridiron valve to oscillate with the Corliss valve *B*. The crosshead *I* does not oscillate, but has a sliding motion in the bonnet *L* from the cam bar *H*. At high rotative speeds it has been found preferable to substitute a link-driven mechanism for the cam on account of the liability of noise if the cams are not carefully fitted.

The outlet drive mechanism is shown in Fig. 1, and consists of an arm keyed to the crankpin of the engine and set so that the pin at its end describes a circle. A quadrant *O* is fitted to the engine frame. In this quadrant slides a block to which is attached the link. The position of this block is governed by the piston in the relay oil cylinder *P*. The pressures in the blast pipe and blowing cylinder act upon a pilot valve which allows oil pressure to enter the actuating cylinder and so place the block in the quadrant that the outlet valve will open only when the pressure in the blowing cylinder is equal to that in the blast

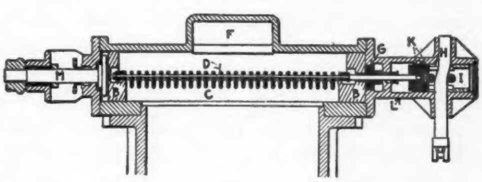

FIG. 5.

pipe. For example, if for some reason or other the blast pressure should suddenly drop, the pilot valve would immediately move, due to the difference in pressure between that to which the air was being compressed and the blast pressure. This movement would allow oil pressure back of the actuating piston and change the piston of the block in quadrant *O* to such a point that the outlet valve *D* would open when the compressed air in the cylinder would equal in pressure that in the blast pipe.

The actions of all the valves are positive. The time of opening and closing the inlet passage to the cylinder is determined by the Corliss valve *B* and is fixed; the inlet is opened when passage *A* is in communication with port *E*. The time of closing the discharge is determined by the Corliss valve *B* and is fixed. The time of opening the discharge is controlled by the discharge valve *D* and depends upon the pressure of air in the cylinder with relation to that in the blast pipe. There is never any possibility of the inlet and outlet ports being opened at the same time and the gas coming back from the blast furnace. —*Power.*

MONEY SAVED?

A gentleman [This is English, you know] had become convinced that a tin lode existed in the Saltash neighborhood, Cornwall, England, and considerable sums of money were spent in trying to locate the lode, but without result. At this period the gentleman came into contact with a miner—an experienced Cornish underground man of the best type. The miner said to the capitalist that he would show him a good lode on condition that the sum of 5 pounds were paid to him for his trouble. His offer was quite ingenuous, because he specified that, if the lode were not found he was content to receive nothing at all. The miner supplemented his offer by undertaking to open the lode, with the aid of three other men, and to work for two days—the capitalist paying labour charges only in the event of a lode being found. Here was a "sporting" offer. The miner's conditions were actually refused! The capitalist, in effect, said that the miner ought to disclose the lode for nothing! Naturally, the miner turned on his heel and went his way. Probably the capitalist is still digging and delving in the hope of finding the lode.

THE SECOND SIMPLON TUNNEL

One of the most important engineering undertakings at present being carried out in Switzerland is the completion of the second Simplon Tunnel, an interesting account of which, here given in abstract, is furnished by a Swiss correspondent of *The Engineer*, London.

Work was begun on the north side on December 20, 1912, and on the south side on March 30, 1913. About 2 miles 1300 yards have now been completely excavated, and 2 miles 780 yards completely lined with masonry; while it is hoped that in all 3 miles 618 yards will be excavated during the present year, and the same length lined, so that, should nothing happen to disturb these calculations, 51 per cent. of the total length will have been excavated by the end of 1914, and 49 per cent. lined with masonry. The second tunnel will be slightly more than 24 yards longer than the first, being 12 miles 588 yards in length.

The ordinary visitor to Brigue— or, for that matter, to Iselle—where are the north and the south portals respectively, sees little to indicate that a great enterprise is being carried out. Outside the actual portal of the tunnel, however, there are many signs of activity and of something going on within. At times a tiny compressed air engine, Fig. 1, may be noticed pulling long strings of small trucks, filled chiefly with artificial stone and bags of cement going in, and with excavated material coming out. Besides these small trucks there are, ready waiting, a number of ordinary broad-gauge trucks, all marked "Simplon Tunnel II." These, however, will be used only for quite the innermost part of the tunnel, when a considerable stretch of the portion near the portal has been completed.

There are also various buildings; that, for instance, from which the whole enterprise is being directed, the same building as that from which the first Simplon Tunnel was managed; but most striking of all in appearance, because of their red colour, are the air reservoirs containing air at as high a pressure as 190 atmospheres (say, 1¼ tons per square inch) for furnishing the power for the engines and for the rock drills. A pressure of from 180 to 190 atmospheres is required for charging the air reservoirs of the engines, but for the drills only from 6 to 8 atmospheres.

As is well known, the shaft of the second

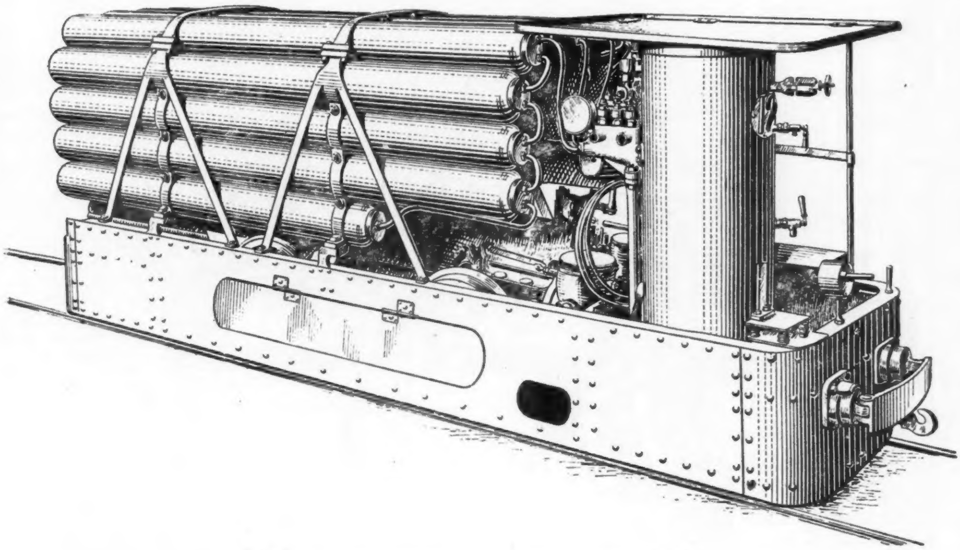

FIG. I. COMPRESSED AIR MINE LOCOMOTIVE.

Simplon Tunnel, a working gallery 3.20 m. wide and 2.5 m. high, was pierced parallel to the first tunnel as the work proceeded, and was connected to the latter by transverse galleries every 220 yards. It is generally admitted that, without this system of parallel shafts and transverse galleries for drawing off water and for ventilation, the first Simplon Tunnel would have taken consideraly longer to construct, and would have required correspondingly more capital. This second tunnel is being formed by enlarging this gallery.

A point of considerable interest in the construction of the second tunnel is the masonry lining, which does not consist of natural stones, as is the case with most Alpine tunnels, but of artificial stone composed of cement, limestone and sandstone, and made in the shape of ordinary bricks, although, being whitish-grey in colour, it does not look like bricks. This artificial stone is manufactured in works in Brigue, close to the north portal of the tunnel I may say here that there was strong opposition at first to its employment, principally because it was feared that it might not prove strong enough to withstand the pressure brought to bear on it. It should be stated, however, that this stone is used only in the dry portions of the tunnel, natural stone being used in the wet portions and in places where the pressure is very heavy, both for the roof of the tunnel and for the abutments. What apparently turned the scale in favor of these artificial stone-bricks is the success with which composition stone and ordinary bricks have been used in tunnels in England. Moreover, the lining of the tunnel with these light artificial stones, uniform in shape and size, is far simpler than with natural stone, which must always be brought from some distance, and often from very far, in huge blocks. With artificial stone, moreover, a good deal of machinery can be dispensed with, notably the compressed air winches for lifting the stone up, which are notoriously troublesome to manipulate; and in the present case, when the first tunnel can naturally not be used for any purposes whatever, the saving of space is a great desideratum.

Since July excavation has been going on by means of rock drills—see Fig. 2—worked, as already stated, by compressed air. Everything, in short, is done by compressed air, and consequently the ventilation has proved satisfactory, despite the length of the tunnel. Save for the smoke from the blasting, there is, indeed, little to foul the atmosphere.

From May 23rd last, when the north heading was at kilom. 4 until the end of July, the work of boring had to be accomplished by hand. Towards the end of the month, however, a number of rock drills were introduced,

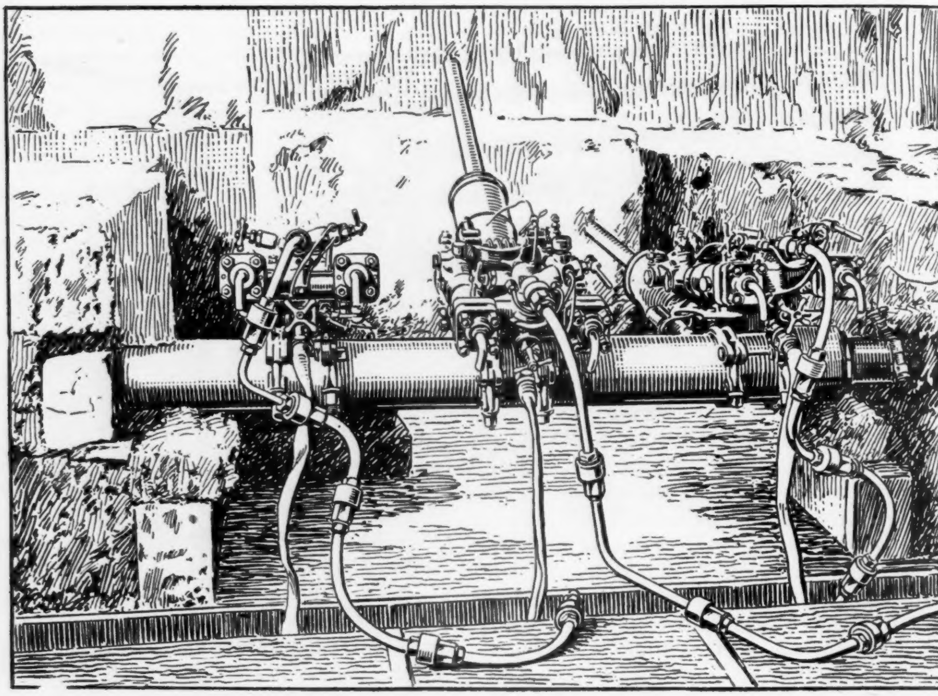

FIG. 2. ROCK DRILLS IN SECOND SIMPLON TUNNEL.

and work progressed much more rapidly. In this part of the tunnel it is essential to begin the lining without delay as soon as the excavation is complete, for the rock must not be left exposed to the influence of the atmosphere a single day longer than is absolutely necessary. In this part of the tunnel timbering is employed to withstand some of the immense

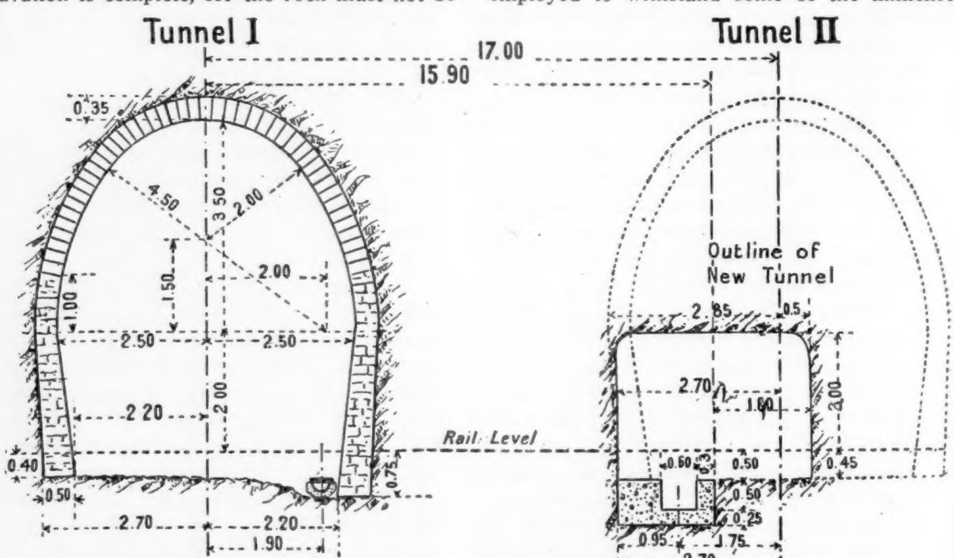

FIG. 3. SKETCH OF THE TWO TUNNELS.

pressure, while for safety's sake, in the first tunnel, in places which showed signs of having suffered slightly, iron centerings have been built in, the intervening spaces being filled in with strong iron plates.

No blasting takes place in the second gallery when a train is passing through the first, because of the transverse galleries and because the distance between tunnel and heading is only about 26 ft. It is sometimes urged that this distance is too small, and the calculations as to the sum at which the risk involved in completing the second gallery should be put were all based upon the fears entertained of injuring the first tunnel while blasting was going on in the second.

The latest figures available—those of November 30th, 1913—show that on the north side, on which work had then been going on almost a year, a mile and a-half were completed, and on the south side three-quarters of a mile, of 11.5 per cent. on the north side and 6.5 per cent. on the south side—altogether 18 per cent. of the total length of the tunnel.

The Simplon Tunnel, it should be recalled, is the lowest of the great Alpine tunnels, its greatest altitude being only 2313 ft. above the sea level, which is 1476 ft. lower than the highest point in the St. Gotthard Tunnel.

As will be seen from the accompanying sketch, Fig. 3, the present distance, axis to axis, between the first tunnel and the gallery or heading is only 15.90 m. (slightly over 52 ft.), but when the second tunnel is completed the distance from axis to axis will be 17 m., or 55 ft. 9 in.

In connection with the second Simplon Tunnel, it is interesting to recall the lengths of the five chief Alpine tunnels, together with the time which they occupied in construction. The tunnels are named in order of date of construction.

Tunnel	Yrs.	mths.	Length, Miles.
Mont Cenis	13	1	7½
St. Gotthard	7	4	9¾
Arlberg	3	0	6¼
Simplon	6	6	12¼
Lötschberg	4	0	9

SWALLOW ENGINEERING

North of Burlington, Vermont, lies a broad sand plain high above the head of Lake Champlain, through which the Central Vermont Railroad was to be carried with a tunnel. The sand, destitute of moisture, would not cohere, but crumbled away as soon as any excavation was made.

After several costly trials the engineers decided that the tunnel was impracticable. A young man in the engineers' office said he could tunnel the sand bank at small cost. He said that he could build the tunnel for so many dollars a running foot, but that he couldn't expect the railway people to act upon his opinion when so many American and European engineers had given it up. The managers, however, gave him a contract to build fifty feet of the tunnel.

On the face of the sand bank he marked the line of an arch larger than the proposed tunnel, and on this line drove sharpened timbers into the bank. Then he removed six feet of the sand and drove in another arch of twelve feet timbers, removing six feet more of sand. This process he repeated until he had space enough to begin the masonry. As fast as the masonry was completed the space about it was filled, leaving the timbers in place. He pierced the bank with the cheapest tunnel ever built, and it now stands as firm as on the day it was finished.

He was asked whether there was any suggestion of the method adopted by him to be found in the books on engineering. "No," he said, "it came to me in this way: I was driving by the place where the attempts were made, and saw that a colony of swallows had made their homes in the bank. It occurred to me that these little engineers had disproved the assertion that the sand had no cohesion. As at every swallow's home there is a self-sustaining tunnel without masonry, I thought that by extending their method I could build a larger tunnel. The bank swallow is the inventer; I am simply his imitator."

HIGH PRESSURE CAISSON WORK

In the construction of the piers for the Boulak Bridge over the Nile at Cairo, completed in 1912, the air pressures worked in by the "sand hogs" were near the record for such operations. For one pier the bottom of the caisson was 111½ ft. below the water surface, while for five piers the depth was 108 ft., and the air pressure carried reached as high as 50 lb. The working shifts for the different pressures ranged as follows:

Up to 28 lb., two gangs working 8-hr. shifts alternately.

28 to 40 lb., three gangs working 8-hr. shifts.

40 to 45½ lb., three gangs, each 6-hr. on and 12-hr. off.

45½ to 50 lb., six gangs working 4-hr. shifts.

50 lb. (during concreting of working chamber), four gangs working 3-hr. shifts, day only.

The time the men were required to stay in the air-lock for "decompression" on leaving the lock, varied as follows: Up to 35-lb. pressure, 1 min. for each 1.4 lb. of pressure; 35½ lb. to 42½ lb., 35 min.; 42½ to 45½ lb., 40 min., 45½ lb. to 50 lb., 45 min. Considering the long shifts and high pressures, cases of illness resulting from these conditions were not very numerous. Out of 493 men employed 100 were reported ill, the number of cases being 115. Of these, four proved fatal. The men were natives, and no difficulty was experienced in getting them to work in compressed air at ordinary rates of pay.

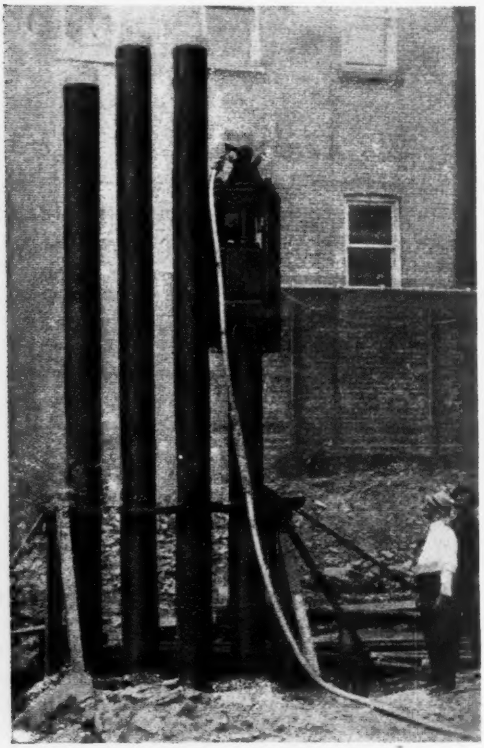

FIG. 1.

FIG. 2.

STEEL COLUMN CONCRETE FOUNDATIONS

In the preceding volume of COMPRESSED AIR MAGAZINE, at page 6736 we describe a method of constructing foundations for high-class buildings which is now being extensively employed, especially in upper Manhattan, New York City, by the Underpinning and Foundation Company. It consists essentially in avoiding deep and costly excavations by instead driving vertical steel tubes 12 in. or more in diameter, down through sand, gravel, etc., until the solid rock surface is reached and filling the tubes with concrete reinforced by steel rods, compressed air being an essential agent in the operations. We here reproduce from the Scientific American a number of illustrations which show the details of the work very clearly.

In Fig. 1, we see several tubes in position for driving, with a special, self-contained air operated hammer in the act of driving one of the tubes. If the ground is very deep or hard the

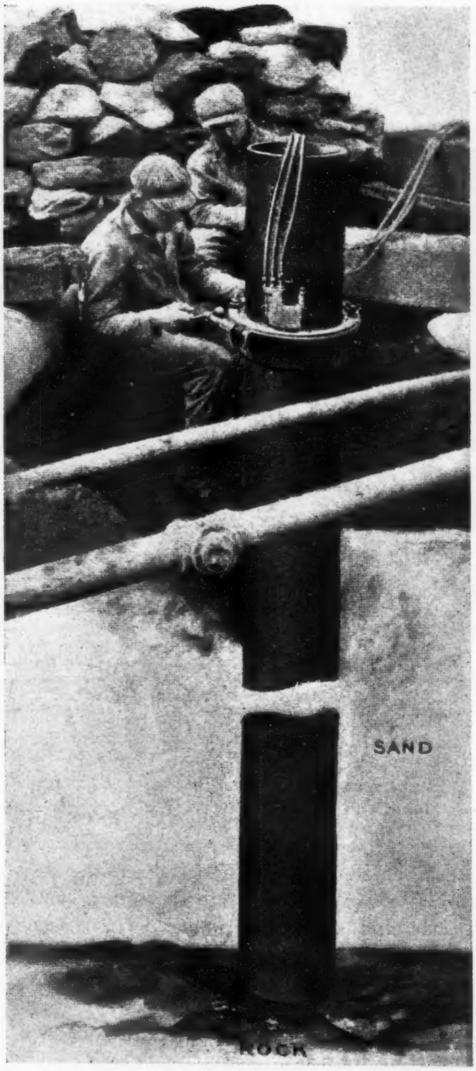

FIG. 3.

tube is not driven entirely home by the first, or even by the second driving. When the tube ceases to advance freely under the blows of the hammer, the driving is stopped, the hammer is lifted and swung aside by a derrick and a Navy air hose is then passed down the tube as far as it will go, and high pressure air is turned on in full volume and as suddenly as possible, which drives up a great quantity ot sand and stones. Fig. 2 shows one of these blow-outs.

After this the driving is resumed, followed

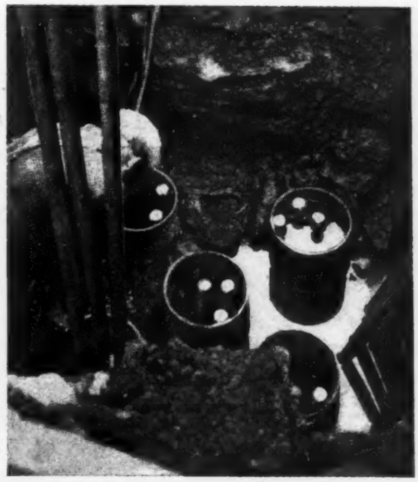

FIG. 4.

by another blowout. When the tube is down to the rock the air blows the surface clean and an electric light is lowered to show that it is all right, also steel sounding rods are used to test the soundness of the rock. This being found satisfactory, three or four 2-in. round steel rods are stood up in the tube and then it is filled with concrete even with the top.

The limit for single lengths of tubing is 20 or 22 feet, and when, as often happens, a greater length is required there are butted sections connected by watertight couplings. In any

FIG. 5.

case the precise length for any tube cannot be determined beforehand, so that after a tube is driven down to the rock the top is cut off to the required length by the oxy-acetylene torch as shown in Fig. 3. In Fig. 4 we look down upon the tops of three or four of the tubes partially filled with concrete, showing the reinforcing rods in position and in Fig. 5, are shown the tops of contiguous piles completed and ready for their permanent load. How this is applied is sufficiently suggested in the sketch, Fig. 6.

The carrying capacity of these piles is enormous, a single 12-in. pile sustaining safely a load of 100 tons. Piers composed of groups of 16 of these piles have been used and the loading of such piers up to 1300 tons is not unusual. As the entire pile is tightly enclosed the possibility of deterioration by corrosion is found to be practically negligible.

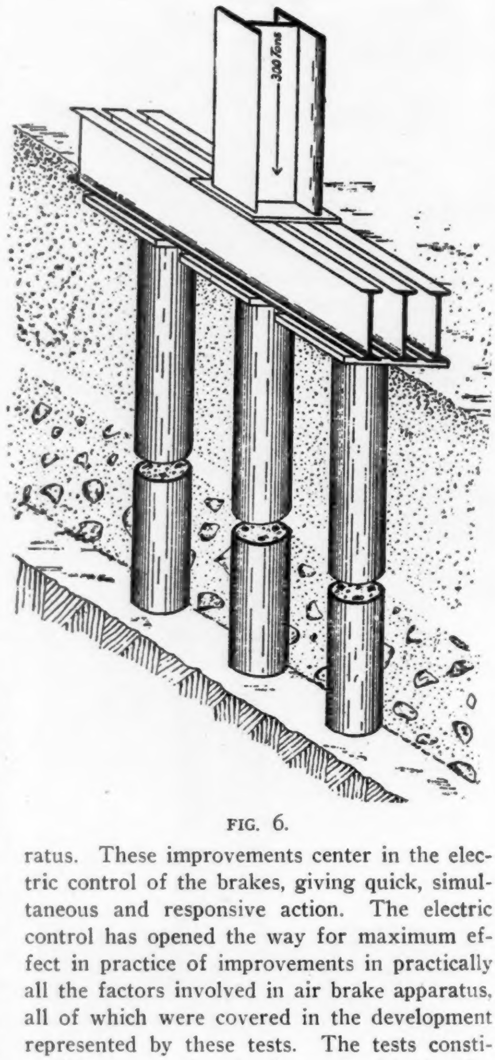

FIG. 6.

PENNSYLVANIA RAILROAD AIR BRAKE TESTS

An unusually interesting paper, discussing the modern air brake problem and giving account of elaborate tests made by the Pennsylvania Railroad, jointly with the Westinghouse Air Brake Company, was presented at the February meeting of the American Society of Mechanical Engineers, by Mr. S. W. Dudley, of Pittsburgh.

A train of 12 steel cars at 60 miles per hour stores up 224,000,000 foot pounds of energy. This is sufficient to raise the entire train 120 feet. With prevailing brake equipment such a train would be stopped by an emergency application in a distance of 1600 to 2200 feet, according to the truck rigging and brake shoe design. These tests showed that this distance has actually been reduced to 1000 ft. or to within the length of the train. This was the result of improvements in the truck brake design, involving the clasp brake, having two shoes per wheel, and the loctaion of the brake shoes with reference to the horizontal center line of the wheels, in addition to improved methods of applying the air brakes quickly and simultaneously and at a high pressure.

These tests emphasized, as has never been done before, the possibilities of improvement in efficiency and economy in regular service operation by proper attention to design and installation in order to permit the realization of the flexibility of improved air brake apparatus. These improvements center in the electric control of the brakes, giving quick, simultaneous and responsive action. The electric control has opened the way for maximum effect in practice of improvements in practically all the factors involved in air brake apparatus, all of which were covered in the development represented by these tests. The tests constituted a progressive development of brake rigging and brake shoes in connection with the scientific study of the air brake as a whole.

Trains of fifteen years ago were stopped in about half the distances prevailing in the practice of to-day. Increased size and weight of equipment brought an entirely new brake problem. These tests have solved it very completely.

The cost of making a ton of ice is: Coal, 40 cents; labor, 50 cents; ammonia, 10 cents; water, 5 cents; wasted power, oil, etc., 10 cents; total, \$1.15.

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MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

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CONTENTS

WESTINGHOUSE

The measure of greatness in men is achievement, and when we are able to gauge one's achievement not alone by its magnitude but by the good that has been done to mankind or to the world in general, that man is truly great. Westinghouse has left a lasting impression upon the industrial world by useful inventions, through the establishment of great business enterprses and in the strength of his noble personality. In lays of ancient Rome we read of men who were called great because they led armies to victory. Through such men the Empire was extended. Greece produced men great in art and letters and to such men as these monuments have been erected as examples to mankind. But it was not until Sir Isaac Newton unfolded the mysteries of Nature that the engineer and the man of science were looked upon as great. Sir Isaac Newton in the evening of his life said: "If I have done the public any service it is due to nothing but industry and patient thought," and it may well be said of Westinghouse that industry and patient thought have entered into every part of his life.

We see the great spectacle of human achievement in a man who labors day and night and produces something which adds to the happiness, prosperity and wealth of the world. Stevenson was the pioneer in transportation, and transportation is the means by which the world has been civilized and enlightened. Westinghouse followed Stevenson and made that transportation efficient and safe. He took our common neighbor, the air, and directed it to useful service. He led in the long distance transmission of electric power and he built great industries.

Westinghouse was great in his private life, great in character, in sympathy, in human interest and in that gentle personality and modesty which are so rare among inventors and men of activity and force. He was

"Of manners gentle, of affections mild,
In wit a man, simplicity a child."

COMPLETE CYCLE OF ROCK DRILL DRIVES

In our March issue, page 7155, there appeared a brief description of the new gasoline driven air pulsator percussion rock drill. While the drill is interesting in itself, having demonstrated its high power economy and complete practical success in operation, the real significance and importance of its appearance at this time may not at once be fully realized. It is to be noted that the drill successfully completes the cycle of possible applications of power to the driving of the reciprocating percussion rock drill.

In the beginning, as we all known, the modern rock drill was developed for mining and tunneling purposes, and compressed air for driving it thus found its first important and constant employment. Drills of the same general type, when their work was not underground, were quite generally driven by steam direct, and practically no other drive but air or steam was known for rock drills until well within the present century.

When electricity was beginning to get into full swing as an agent for the transmission of power to every mechanical device, the rock drill field could not be overlooked or ignored, and so experts in great number have struggled long to produce a satisfactory electric driven rock drill, but no device of that class has yet passed the stage of unsuccessful experiment, but all at once the electric-air drill appeared, and this not only solved the problem of the electric drive completely, but without sacrificing any economic advantage of the older types of drills, has developed additional desirable features of its own.

With the gasoline drive doing the wonders that it has done for the automobile, and especially in its having put the breath of life into the aeroplane, it was quite natural to think of its possibilities in connection with the rock drill. The history of the attempted adaptation for this latter service is quite similar to the electric record. There has been no lack of experimenting but a plentiful lack of success. The internal combustion principle is apparently no better adapted to the direct driving of a rock drill than is the electric current; at least it has no better success to show, but here too in the gasoline air drill the complete solution has come all at once and beyond further question.

The reciprocating rock drill can now be driven by either air or steam direct, by electric current or by gasoline, with the highest known efficiency whichever drive is adopted. This variety of drive enables the drill to be used in all localities accessible to man and under all possible conditions of working. In no case is any experimenting required as to what the drill will do or what will be the approximate cost for the doing of it.

It is a singular and notable fact that while there are now several builders of rock drills driven by air or by steam, one firm in all the world has the unique distinction of manufacturing drills operated successfully by either of the available drives here spoken of.

THE BREAKING OF DRILL STEELS

At a recent meeting of the Mining and Metallurgical Society of America an interesting discussion occurred (Bull. No. 68.) concerning the inability of drill steel to stand up in hammer drills.

Mr. LeFevre said that at Mineville in the use of hammer drills the difficulty had been to find the right material. Cruciform 1 in. stock did not seem to have enough metal, so that the company expected to try 1¼-in. octagon. The jackhamers using round hollow steel, break the shanks when the hole gets down 6 or 7 ft., and the borings do not come out freely.

Mr. Spilsbury stated that the peculiar fractures to which the hollow steel drill, under the impact of the hammer, seemed to be subjected, did not appear to be due simply to the actual blow of the hammer, but to an interior condition of abnormal strain in the structure of the steel itself. He thought that possibly the trouble was due to the method under which these hollow drills are produced. The ingot is first punched and then forged down on a mandrel. Any defect or ragged edge, on the punch originally used would cause striations along the interior surface of the hole and in the subsequent hammering down over the mandrel, these lines would never be entirely obliterated. The grooves might be closed but would probably include a slight film of oxide in their folds which would still remain in the finished drill, and under the jar of operation would naturally become a source of weakness This trouble would also be increased by the unequal annealing of the material during the time of its reduction, owing to the fact that surfaces exposed to the mandrels would be cooled more rapidly than the rest of the material and shrinkage strains would probably be

set up. He believed that this was the direction in which to look for the cause of the rapid failures rather than to the quality of the steel.

R. M. Catlin said he had an idea that the breaking of the drills was due to inequalities in the steel, although he had never seen a longitudinal fracture in a drill. The fractures with which he was familiar indicated a nucleus, and correlation indicated that the fracture had begun from this nucleus and spread outward. As is observed in a flaw in glass, these were concentric rings spreading out from a central point. It seemed as though there were in the nucleus some substance which had developed, under the strain of the vibrations or of heat, a tendency to expand more than the elasticity of the steel could accommodate. This nucleus seemed to run through the length of the steel, and if broken anywhere, one could expect to find it. There can be had steel of all kinds and prices from 5c. to over 30c. per lb. As a matter of fact, the higher-priced steel does not seem to be the more durable. A trial of hollow steel having an absolutely round hole, gave no better results, even though it was a drilled hole.

W. L. Saunders said his company had experimented a great deal on the subject of the round hole. The steel problem is being solved, he said, not by American, but by foreign metallurgists, and the steel with a hole in it that is now standing up best under the hammer blow is of foreign make. Referring again to the difference between a piston and a hammer drill, in the latter the bit is pressed against the bottom of the hole, and is then struck a thousand blows per minute. Probably 10 per cent. of the blows are struck when the bit does not touch the bottom of the hole, since one cannot press a piece of steel against the bottom of a hole and hammer it without the steel's bouncing back.

Cars of improved design for the New York Subway will cost $10,000 apiece. These cars are 67 ft. long and 10 ft. wide, compared with 51½ ft. and 8¾ ft. respectively for the existing subway equipment. The car bodies will cost $6119 each; the motor equipment, $1100; control apparatus, $975; brake set, $911; each truck, $450; total for each car, $10,005.

COMPRESSED AIR IN CYANIDATION*

Compressed air has long been used in various branches of metallurgy for the ordinary mechanical purposes common to every industry, but in the cyanide process of recovering gold and silver from their ores there are several applications peculiar to that system which do not apply to industry in general and which may be of interest. Especially is this true regarding that modern development of the process known as "all sliming," in which ore containing precious metal is ground to such a point that nearly all of it will pass a fine wire screen having 200 openings per lineal inch, and is then stirred or agitated with the cyanide solution.

In the early days of cyanide metallurgy, the approved method of treating an ore was to grind it rather coarsely, place it in a tank containing a filter bottom, and leach it with the cyanide solution. By this method the surface of the charge in the tank—that portion exposed to the action of the atmosphere—gave a good extraction of its contained metal, while the interior of it—that portion with which the air could not come into contact—was found to give up its metal content at a much slower rate and in less degree.

Believing that oxygen was what was needed, some operators introduced compressed air under the filter bottom and forced it up through the charge, aerating the material thoroughly. This was one of the first uses, if not the actual pioneer application, of compressed air in practical cyanidation. The idea was even covered by patent, the scheme being to fill the bottom of the tank, under the filter, with a net work of stationary pipes perferated with small holes into which air could be forced to find its way through the sand in the tank. This operation was sometimes varied by connecting the bottom of the tank with the intake of a compressor, drawing the air down through the charge. This latter procedure was found to induce packing of the charge and was not considered as satisfactory as forcing the air upward, which loosened the sand and made it more permeable.

Finding that fine material interfered with rapid and even leaching of the tank contents,

*From an article by Herbert A. Megraw in Engineering Magazine, January, 1914.

the two were separated and the clean sand leached by itself, a much more satisfactory method. The finer material, at first discarded, was later found to contain a good proportion of the valuable metal, often the most of it, and the problem of its treatment arose. It could not be leached, as it was too fine and packed so tightly in the tank as to be practically impermeable, and the only way in which it could be satisfactorily extracted was to keep it in suspension in cyanide solution while the dissolving progressed, and to separate the two after the extraction of the valuable metal was complete. The fine material, by common consent, has been called slime; and while the exact definition of the word has been the subject of much controversy, it is generally taken to mean the extremely fine clayey or colloid portion of the ore which may not be successfully leached. Its treatment bothered operators for many years, and in the devising of an applicable method, the agitation system, now highly perfected, was born.

At the mill of the El Oro Mining & Railway Co., at El Oro, Mexico, one of the early plants in America to attempt the separate treatment of slime, the material was agitated in shallow, rectangular tanks by means of compressed air introduced through a hose moved from point to point by an operator. The system made use of the mechanical efficiency of the air in keeping the solids in suspension, and also the oxygen in the air to supply that necessary in the completion of the chemical reaction. This method was troublesome and expensive, requiring too much labor to be economical, and was soon replaced by round tanks in which the agitation was mechanically done, using a central vertical shaft provided at the bottom with arms for keeping the solids in suspension, and air was added either through fixed pipes in the tank or into the suction of a centrifugal pump used to assist agitation. A later development made use of a hollow vertical shaft through which air was introduced, passing thence through hollow agitating arms and escaping through a series of small holes, thus combining mechanical and air agitation at the same time. These methods gave good results; but the notion of "killing two birds with one stone" had not been forgotten, and agitation by means of compressed air alone was studied until the tank known as the "Brown" or "Pachuca" was developed and became almost universally used.

The "Brown" tank is a tall cylinder of steel plate having a cone-shaped bottom and is fitted with a tube vertically placed in the center. This tube acts as an air lift, raising the mixture of solid and solution and discharging it near the top of the tank, thus maintaining a constant circulation and giving no opportunity for the solids to settle. The tank is very tall in comparison to its diameter, made so in order to minimize the chance of settling; and to further this object, the cone bottom is made so steep that solids can hardly remain on it. The usual dimensions of a standard tank of this kind are about 15 feet in diameter and 45 feet deep, although in some cases the proportions are varied. The central tube reaches from near the bottom of the tank, where compressed air is admitted, to within a few inches of the top. This latter point is the subject of many variations, some operators maintaining that the necessary conditions are complied with when the tube reaches only half way up the tank. It will be seen that this is an air lift working under practically ideal conditions as to submergence, and power requirements are not large. In a standard tank, which will hold about 100 tons of dry slime at the usual dilution, the operation is stated to require about 100 cubic feet of free air per minute, compressed to 25 to 50 pounds per square inch. The higher pressures are required to start operations after the tank has been without agitation for some time, and the lower ones to maintain agitation after it has been started.

Many other systems have been invented and put into use, most of which use compressed air as motive. One known as the Trent system operates by the use of a centrifugal pump in a tank of large area, having a flat bottom, and comparatively low. Such tanks may be 20 to 30 feet in diameter and 10 to 15 feet deep. The pump is fed from a point near the surface of the tank and forces the pulp through an appropriate gland in the tank bottom into a system of arms, made of pipe, placed so that they may revolve near the bottom of the tank. The arms are fitted into a grit-proof bearing, and the pulp exits are all curved in one direction, the force of the discharging pulp causing them to revolve in the tank after the fashion of an automatic lawn sprinkler. To supply oxygen to this system, air is introduced into

the pump column from a compressor; or this may be done by arranging a sniffle valve in the suction, although this is likely to reduce the efficiency of the pump.

Probably the latest claimant for honor as an agitator is that known as the Dorr, which uses a flat-bottomed tank like that in the Trent system. The mechanism is like that used with the well-known Dorr thickener—a central shaft carrying two arms, inclined upward at an angle from the centre. Upon the bottom of these arms are a series of inclined blades, which act as rakes, drawing the settled material toward the centre of the tank. Upon reaching the centre, the slime comes under the influence of an air lift, which circulates it much as it is done in the Pachuca tank. The discharge of this air lift may be free, as in the Pachuca tank, or through a distributing canal fastened to the central shaft; in the latter case the discharged slime is distributed over the entire surface of the tank. Here again the air is made to serve two purposes. The particular advantage claimed for this tank is that it requires very little power, the mechanically moved arms revolving very slowly and requiring only from ¼ to ½ a horse power, while the air lift has no great height and small quantities of air under low pressures may be used. Tanks with flat bottoms and great area, compared with their height, are preferred on account of their low installation cost and also the influence upon the first cost of the milling plant. When tall tanks are used, costly excavations are required in addition to the heavy installation expense of the tanks themselves.

In addition to the uses named, compressed air performs many other duties about the cyanide plant, most of which, however, are purely mechanical. The air lift is used for elevating both pulp and solution, and compressed air is often used in connection with filtration, the separating of the solids from their treatment solutions. The precipitate resulting when gold and silver are thrown out of the solution is pumped through a filter press, either by means of direct-action pumps or by a monteju, and the cake formed is often partially dried by passing compressed air, sometimes heated, through it. Compressed air is largely used in the operation of fuel-oil burners to melt the precipitate into bullion, and in many other ways this transformation of energy may be considered almost indispensable about the modern cyanide plant. While all of these uses are important, naturally the one in which both chemical and mechanical properties are utilized is most prominent.

MINE ACCIDENTS

The report of the Bureau of Mines on metal mine accidents in the United States in 1912, shows 661 men killed, 4,502 seriously injured and 26,232 men slightly injured out of a total number of 169,199 men employed. The figures show a decrease of thirty-four deaths from 1911, despite the fact that Alaska, with twenty-one fatalities is included for the first time in the 1912 report. The death rate for 1912 was 3.91 for every 1,000 men employed as against 4.19 in the year 1911. The report on metal-mine accidents completes the mortality statistics for the mining industry for the year 1912 and shows in coal mining, metal mining and quarrying, a total of 3,234 deaths for the year, with a death rate of 3.22 as against 3.602 deaths in 1911 and a rate of 3.58 in every 1,000 employed.

This report has been published as Technical Paper No. 69, copies may be obtained by addressing the Director, Bureau of Mines, Washington, D. C.

MINING NOT THE MOST DANGEROUS

Recently the casualty statistics for persons employed in coal mines, on railroads and in steel mills of the United States, in the year 1911, were assembled for comparison. It was seen by the comparison that, for each thousand men employed, fewer coal miners were injured than railroad men or steel workers. Bulletin 69, of the United States Bureau of Mines shows that in 1911, the number of coal miners in this country was 729,279. Of this number 31,334 were injured more or less seriously. In the same year, according to the "Twenty-fifth Annual Report of the Interstate Commerce Commission," the railroads employed 1,669,809, and of this number 126,039 were injured. United States Senate Document 110, Sixty-Second Congress, bears testimony to the fact that 35,764 steel workers were injured of 158,604 employed.

A study of the figures contained in these government documents shows that there were

about half as many coal miners as railroad men employed, and that less than one-fourth as many were injured. It is also shown that, while the mines employed 570,675 more men than the steel mills, the steel mills injured 4430 more than the mines did. A reduction of the figures to a common basis brings out the fact that, for each 1000 men employed, 42.96 were hurt in the coal mines, 75.48 on the railroads, and 225.4 8 in the steel mills.

AN APPRECIATION OF RATS

There is at least one region in the United States where rats are held in high regard. This is the copper mining district of Michigan. The regard entertained for the rodent does not, however, apply to the rats which dwell in and about the habitations of man. It is extended only to rats which never see the light of day, rats which make their homes hundreds and thousands of feet below the surfact of the ground—rats which frequent the copper mines. Rodents above ground are carriers of disease as well as costly preyers on the food and the buildings of man. Rodents underground are valuable to sanitation, preventives of disease; they indulge in no depredations for the reason they exist within rockbound walls enclosing no things possible for animals such as they to destroy.

Rats are the scavengers of the mines. They keep the workings clear of refuse. They are protected by the men, are often fed from dinner pails and have become so accustomed to the miners that they frisk about the workers wholly unafraid, secure in the apparent realization that, while elsewhere they are hunted and slain as enemies of mankind, underground they are treated as allies and are immune from harm. With their very existence concerned, no living creatures suffered more from the strike of the Western Federation of Miners in the copper country than did the mine rodents Not only was the food supply cut off in most instances, resulting in a heavy mortality from famine, but large numbers of rats were drowned when the pumps draining some of the shafts were put out of commission and workings filled with water. It is believed the survivors owe their continued existence to cannibalism. The strike is in progress only in theory now and mining operations are fast approaching the normal; but while the rats are far fewer in numbers, no carcasses are to be seen. The conclusion is obvious.

The rodent population of the mines apparently comprises various branches of the rat family as well as a conglomeration of several. There are white, brown and black rats, and rats with combinations of colors; there are rats of various sizes and of somewhat varied shapes; some with long tails and some with short. At some shafts food was especially provided during the period the workings were deserted of men; but in general the rodents were left to work out their own salvation. It will be a long time before the rats regain their normal numbers. These numbers are never such that the mines are overrun. Notwithstanding no warfare is waged by man, the rat population does not grow to proportions where it becomes a menace or a nuisance. Nature apparently regulates, and cannibalism no doubt plays a part. Rats have frequented the mines for many years, and yet in no case have they become in any way undesirable.—*Min. and Eng. World.*

NITROGEN DOUBLES LAMP EFFICENCY

A new type of lamp is announced with twice the efficiency of the tungsten lamps now in common use. The new lamp has a filament of tungsten, but the bulb, instead of being exhausted of air, is filled with nitrogen vapor at atmospheric pressure. The peculiar property of the nitrogen is that the tungsten filament may be operated at a considerably higher temperature than when in a vacuum, without the troublesome blackening of the bulb. The experiments thus far have been conducted largely with lamps of high candle-power; one of these lamps was over 6000 candle-power with a current consumption of 0.5 watt per candle, as compared with 1 and 1.25 watts per candle in the ordinary tungsten lamp. Small and medium-sized nitrogen-filled lamps have not yet been successfully operated at this high efficiency, but it is claimed that all tungsten lamps will give better service if filled with nitrogen than if a vacuum is used.

NOTES

The trustees of the village of Southampton, N. Y., have granted a gas franchise to Henry F. Cook of Sag Harbor, N. Y., with numerous restrictions and safeguards, among which

it is provided that no gas holder shall be erected in or within two miles of the village, which puts Southampton ten years, more or less, ahead of New York City.

The heaviest railway construction ever undertaken in British Columbia is the 38-mile section of the Kettle Valley Railway from the Hope Range summit to Hope. This line, which includes 12 tunnels, is estimated to cost $3,000,000.

The largest double-acting pile driver ever built was used for driving concrete piles for the Intercolonial Railway's new pier and shed at Halifax, Nova Scotia. The combined weight of the hammer with follower and follower guide is 24,000 pounds; weight of the ram only, 4000 pounds. The diameter of the cylinder is 14 inches and stroke 36 inches. The hammer drove 1800 reinforced concrete piles 24 by 24 inches square and 37 to 77 feet long.

The extension of the distribution of gas under high pressure for heating and lighting has brought lead wool into prominence among gas engineers abroad. On a long length of 4-inch and 6-inch steel mains jointed with this material in England, a test of 60 pounds of compressed air was applied for a period of six days and nights, but it is stated that no leakage whatever was recorded. In connection with the new water works for Logos, in Southern Nigeria, some 22 miles of 28-inch pipes will be jointed with lead wool, and the caulking is being carried out with pneumatic hammers.

Lomax, a pre-planned city in Henderson Co., Ill., offers some novel inducements for industrial installations. The founders have planned for shipping facilities, power, labor and living conditions. They propose to give each manufacturing plant free power for at least ninety years on the basis of one horsepower for each male employe, charging for additional power at the rate of twenty dollars per horsepower for a year. Workmen's houses will be rented on the basis of two per cent. of the actual cost and the workman will be given a chance to buy and build on small reservations without cash.

At the Liverpool Royal Infirmary recently a tube of radium, worth over 1000 pounds, which had been applied to a patient's face, was missed, and as it was proved with the X-rays that the patient had not swallowed the tube, it was conjectured that it had been swept up from the floor. A cart full of sweepings was detained just as it was about to leave the infirmary, and Professor Wilberforce, of Liverpool University, tested it with an electroscope, which indicated that the radium was in the cart. The rubbish was then placed in buckets, each of which was tested in the same way, and the tube was discoverd in the twelfth bucket.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

FEBRUARY 3.

1,085,598. OZONE-GENERATOR. WILLIAM O. FREET, Hackensack, N. J.

1,085,640. CRYING DOLL. ALBIN STEINER, Sonneberg, Germany.

1,085,756. DEEP-WELL PUMP. THOMAS O. PERRY, Oak Park, Ill.

1. In a pneumatic pump, the combination with a source of compressed air and a plurality of water chambers, each having intake and outlet water valves, of an air-valve adapted to admit and release compressed air to and from said water chambers in succession, a valve-chamber inclosing said air-valve in proximity to said water-chambers, a valve actuating motor remotely placed with reference to said air-valve, an air-pipe for conducting compressed air to said valve chamber and a valve actuating shaft between said valve and said motor.

1,085,771. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Edgewood, Pa.

1,085,896. GUARD FOR PNEUMATIC HAMMERS. HARRY N. EVANS, Sr., Philadelphia, Pa.

1,085,926. APPARATUS FOR PRODUCING VACUUMS. JOHN I. MCCORMICK, Chicago, Ill.

1,085,971. METHOD OF HUMIDIFYING AIR AND CONTROLLING THE HUMIDITY AND TEMPERATURE THEREOF. WILLIS H. CARRIER, Buffalo, N. Y.

1. The herein described method of controlling the humidity of air in an inclosure, consisting in introducing into the inclosure air which has been substantially saturated with moisture, and regulating the temperature at which the air is saturated so as to maintain a substantially fixed difference between the temperature existing in the enclosure and the temperature of the saturated air, substantially as set forth.

1,085,974. TELEPHONE SYSTEM. ELMER R. CORWIN, Chicago, Ill.

1,086,089. MEANS FOR REMOVING MOISTURE FROM AIR AND GASES. PAUL SCHOU, Copenhagen, Denmark.

1. An apparatus for absorbing water vapor from air or other gases comprising an absorbent chamber for containing a liquid absorbent, an adjacent vapor chamber adapted for the passage therethrough of air or gas containing wa-

ter vapor to be extracted, and an imperforate acid proof porous partition between said chambers adapted to pass liquid absorbent into the vapor chamber.

1,086,130. PROCESS OF WORKING WITH HYDROGEN UNDER PRESSURE. CARL BOSCH, Ludwigshafen-on-the-Rhine, Germany.

1,086,222. PNEUMATIC STRIPPING MECHANISM FOR CARDING-CYLINDERS. AUGUSTE ROUGE, St.-Etienneles-Remiremont, France.

1,086,230. AIR-PUMP LUBRICATOR. GEORGE M. SCHWEND, Birmingham, Ala.

1,086,273. PROCESS OF PREPARING FLAX. GEORGE H. CAMPBELL, Toronto, Ontario, Canada.

1. In the art of preparing flax, the improvement which consists in subjecting unretted flax material to the action of ozonized air within a confined space, continuing the operation until the material is retted, and then separating shive material from the fibers.

FEBRUARY 10.

1,086413. PRESSURE - REDUCING VALVE FOR AIRFEED DRILLS. ALBERT H. TAYLOR and LEWIS C. BAYLES, Easton, Pa.

1,086,443. PNEUMATIC - DESPATCH - TUBE APPARATUS. JAMES T. COWLEY, Boston, Mass.

1,086,550. PRESSURE-RELIEF VALVE FOR PNEUMATIC TIRES. WILLIAM J. MORRISON, Sioux City, Iowa.

1,086,561. AIR - CONTROL DEVICE FOR LIQUID-GASES. OLIVER C. RITZ-WOLLER, Chicago, Ill.

1,086,591. VACUUM CLEANING APPARATUS. WILLIAM H. FULTON, Brooklyn, N. Y.

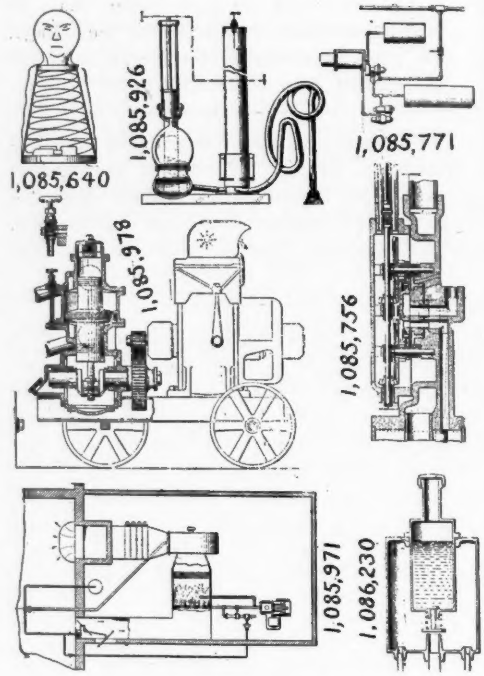
1,086,625. PNEUMATIC ROCK-DRILL. CLARK J. SMITH, Ottumwa, Iowa.

1,086,681. BLAST-PRESSURE-REGULATING VALVE. WILLIAM MELAS, Ridley Park, Pa.

1,086,686. BLOWER. CHRISTIAN NEUMANN, St. Louis, Mo.

1,086,755. ROTARY COMPRESSOR, BLOWER, AND PUMP. CHARLES G. CURTIS, New York, N. Y.

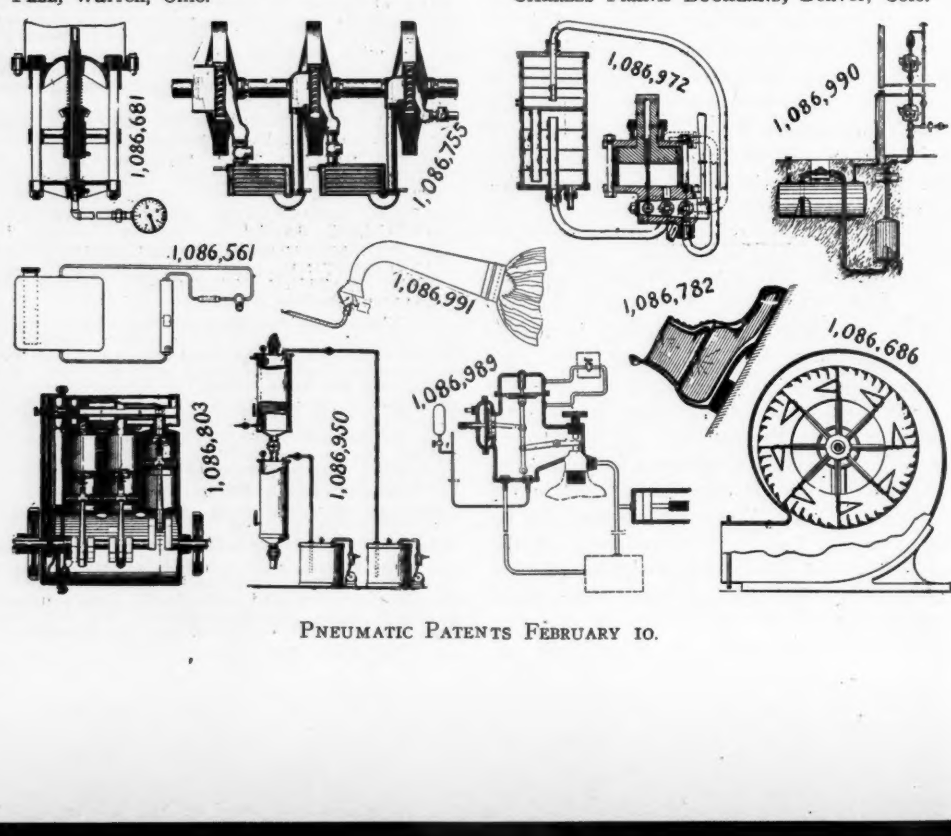
1,086,759. APPARATUS FOR PRODUCING VACUUM IN ELECTRIC LAMPS. LLOYD A. FELL, Warren, Ohio.



PNEUMATIC PATENTS FEBRUARY 3.

1,086,782. PNEUMATIC SHOE-FORM. OMER E. MOORE, Coldwater, Kans.

1,086,803. CONVERTIBLE MOTOR AND PUMP. CHARLES FRANK BUCKLAND, Denver, Colo.



PNEUMATIC PATENTS FEBRUARY 10.

1,086,824. MOLDING APPARATUS. MADDRA JACKSON HEWLETT and HENRY L. DEMMLER, Kewanee, Ill.

1,086,950. PROCESS OF DRYING CORN. CHAS. W. STANTON, Mobile, Ala.

1. The hereindescribed process of drying grain which consists in successively heating and cooling the grains in air-tight receptacles; and maintaining a constant high vacuum in said receptacles throughout such treatment.

1,086,955. PNEUMATIC TOOL. EDWARD M. TOBIN, Barre, Vt.

1,086,972. APPARATUS FOR THE AERATION OF LIQUIDS. FRANK COREY YEO, Dan-y-coed, near Swansea, Wales, and WYNYARD MONTAGU HALL and THOMAS A. GOSKAR, Westminster, London, England.

1,086,989. MARINE SAFETY DEVICE. MAURICE BOUCHET, Paris, France.

1. In a safety device for ships and submarine boats, the combination of a casing, a diaphragm mounted therein, a water-tight compartment communicating with said casing, a series of levers connected with said diaphragm, a compressed air tank, a pipe leading from said compressed air tank to said water-tight compartment, means controllable by said series of levers for opening said compressed air tank, a second casing connected with said first mentioned casing, a diaphragm located in said second mentioned casing and exposed to pressure of air from said first mentioned casing, and an operative connection from said second mentioned diaphragm to said series of levers for the purpose of closing said air tank.

1,086,990. LIQUID-DISTRIBUTING APPARATUS. AUGUSTUS BOWSER, Fort Wayne, Ind.

1,086,991. BUBBLE-BLOWER. CHARLES VERNON BOYS, London, England.

1,086,998. LIQUID-FUEL BURNER. GEORGE EDMOND DENMAN, Fruitvale, Cal.

FEBRUARY 17.

1,087,201. PUMP FOR AUTOMOBILE-TIRES. JOSEPH H. TEMPLIN, Philadelphia, Pa.

1,087,240. FLUID-PRESSURE ENGINE. JOHN KELLINGTON, New Westminster, British Columbia, Canada.

1,087,287. APPARATUS FOR CASTING AND BLOWING GLASS BOTTLES AND THE LIKE. CHARLES I. GEER, Washington, D. C.

1,087,290. APPARATUS FOR COOLING, WASHING, AND DRYING GASEOUS PRODUCTS OF COMBUSTION, AND CHARGING THE SAME WITH FUMIGANTS. GEORGE HARKER, Petersham, near Sydney, New South Wales, Australia.

1,087,329. APPARATUS TO INDICATE THE STOPPAGE OF CARRIERS IN THE TRANSMISSION-TUBES OF PNEUMATIC-DESPATCH-TUBE SYSTEMS. JOHN F. SKIRROW, East Orange, N. J.

1,087,382. CENTRIFUGAL COMPRESSOR. WALTER KIESER, Charlottenburg, Germany.

1,087,399. RELEASE-VALVE. FRANK PHELPS, Little Rock, Ark.

1,087,401. CENTRIFUGAL AIR-COMPRESSOR. RICHARD H. RICE, Lynn, Mass.

1,087,406. AIR STARTING MECHANISM FOR OIL-ENGINES. LEO V. STOELTZLEN, Erie, Pa.

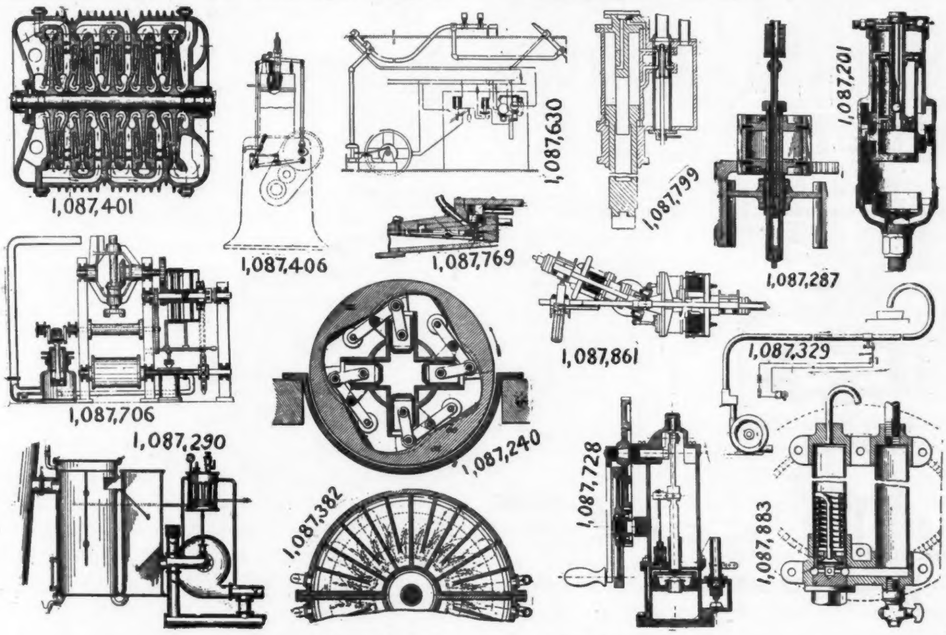
1,087,627. MOTOR. ALFRED ANDERSON, Chicago, Ill.

1,087,630. TIMING MECHANISM. BIRNEY C. BATCHELLER, New York, N. Y.

1. In a pneumatic despatch tube system, the combination with a transit tube, of an air moving device, a motor for driving it, controlling means for said motor tending to maintain the latter in operation, and a timing mechanism comprising a driving shaft, a member normally connected to said shaft and thereby moved into and held in one position in which said member engages said controlling means and actuates the latter to stop said motor, means actuated on each insertion of a carrier in said transit tubing for temporarily disconnecting said member from said shaft at the time of said insertion, and provisions effective whenever said member and shaft are disconnected for moving said member into a second position from which it may be thereafter returned to said one position by said shaft.

1,087,632. ROCK-DRILLING MACHINE. WILLIAM S. BENJAMIN, Seattle, Wash.

1,087,674. PNEUMATIC VALVE. FRANK G. LYNDE, New York, N. Y.



PNEUMATIC PATENTS FEBRUARY 17.

1,087,706. ROCK-DRILLING MACHINE. FRANZ BADE, Peine, Germany.

1,087,728. VACUUM-PUMP. PAUL COLOMBIER, Paris, France.

1,087,769. PNEUMATIC ACTION. ARVIN H. HOPPERT, Ann Arbor, Mich.

1,087,799. ELASTIC-FLUID HAMMER. LEONARD FLETCHER MASSEY and WILLIAM HENRY SNOW, Manchester, England.

1,087,861. FLUID-OPERATED ROTARY PRIME MOVER. GEORGE HENRY ALEXANDER and WILLIAM GILBERT ROBINSON, Birmingham, England.

1,087,862. AUTOMATIC COUPLING AND AIR-VALVE-OPERATING MECHANISM. ARTHUR T. AMES, Blanchard, Me.

1,087,883. PRESSURE-GAGE. OSBORN P. LOOMIS, Newport News, Va.

1,087,906. RELIEF-VALVE. CARL ROY HOUGHTON, Connersville, Ind.

inum sulfate and then adding to the unfiltered water, while an *air-jet* is being introduced into the same and without waiting for the suspended particles to precipitate, a thin watery solution of permenganate of potassium.

1,088,109. PNEUMATIC-DESPATCH APPARATUS. CHARLES F. STODDARD, Rochester, N. Y.

1,088,154. TOOL FOR PNEUMATIC HAMMERS. HENRY KELLER, Chicago, Ill.

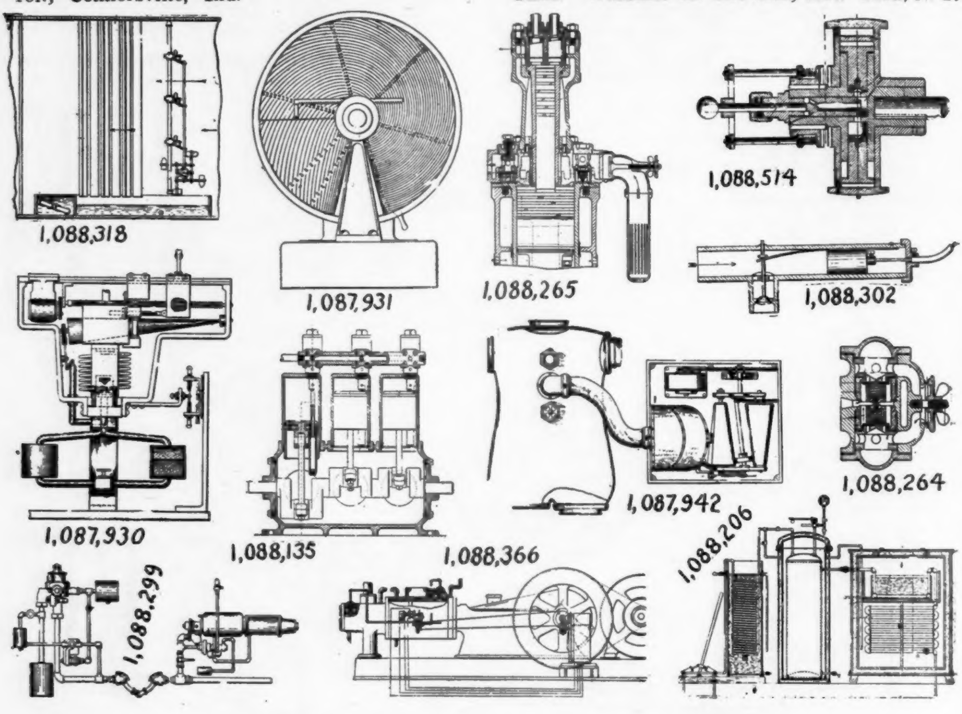
1,088,155. AIR-MOTOR. JUSTUS R. KINNEY, Boston, Mass.

1,088,206. REFRIGERATING APPARATUS. CONFUCIUS CHASE and WARREN A. CHASE, Boston, Mass.

1,088,264. VALVE MECHANISM FOR AIR-COMPRESSORS. CHARLES DAY and GEORGE E. WINDELER, Stockport, England.

1,088,265. AIR-COMPRESSOR. CHARLES DAY and GEORGE E. WINDELER, Stockport, England.

1,088,299. FLUID-PRESSURE BRAKE SYSTEM. WILLIAM H. SAUVAGE, New York, N. Y.



PNEUMATIC PATENTS FEBRUARY 24.

FEBRUARY 24.

1,087,929-30-1-2. METER FOR MEASURING THE FLOW OF AN ELASTIC FLUID. AUSTIN R. DODGE, Schenectady, N. Y.

1,087,942. RESUSCITATING APPARATUS. CHARLES M. HAMMOND, Memphis, Tenn.

1,087,970. APPARATUS FOR TRAPPING SOLID PARTICLES IN SUSPENSION IN GAS-CURRENTS. THOMAS E. MURRAY, New York, N. Y.

1,087,988. PITOT PLUG FOR FLUID-METERS. LUCIAN A. SHELDON, Schenectady, N. Y.

1,087,995. ROTARY FAN. THOMAS JOSEPH STURTEVANT, Wellesley, Mass.

1,087,997. ELECTROPNEUMATIC BRAKE. WALTER V. TURNER, Edgewood, Pa.

1,088,063. PROCESS FOR PURIFING WATER. WILHELM DRECHSLER, Dresden, Germany.

A process of purifying water, consisting in mixing the water with a weak solution of alum-

1,088,302. AUTOMATIC AIR-VALVE FOR GAS-MANIFOLDS. EUGENE T. SCUDDER, Newark, N. J.

1,088,306. PNEUMATIC GOVERNOR FOR MUSICAL INSTRUMENTS. WILLIAM B. TUNSTALL and ALBERT E. TUNSTALL, Worcester, Mass.

1,088,318. AIR PURIFYING AND COOLING APPARATUS. CHARLES H. BICALKY, Buffalo, N. Y.

1,088,334. ROCK-DRILL. HANS EDGAR, Karangahake, New Zealand.

1,088,366. UNLOADER FOR FLUID-COMPRESSORS. WILLIAM PRELLWITZ, Easton, Pa.

1,088,514. FLUID-CLUTCH. IRVIN E. BARRICKLOW, Antioch, Cal.

1,088,585. TURBO-COMPRESSOR. HUGO JUNKERS, Aix-la-Chapelle, Germany.

1,088,663. PNEUMATIC BULB. IRWIN F. KEPLER, Arkon, Ohio.